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V.

- I. EXPERIMENTS ON THE EFFECT OF FREEZING AND OTHER LOW TEMPERATURES UPON THE VIABILITY OF THE BACILLUS OF TYPHOID FEVER, WITH CONSIDERATIONS REGARDING ICE AS A VEHICLE OF INFECTIOUS DISEASE.
- II. STATISTICAL STUDIES ON THE SEASONAL PREVALENCE OF TYPHOID FEVER IN VARIOUS COUNTRIES AND ITS RELATION TO SEASONAL TEMPERATURE.

BY

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PRESENTED MARCH 12, 1902.

(Preliminary Communication, December 13, 1899.)

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PART II.

STATISTICAL STUDIES ON THE SEASONAL PREVALENCE OF TYPHOID FEVER IN VARIOUS COUNTRIES AND ITS RELATION TO SEASONAL TEMPERATURE.

I. A REVIEW OF THE LITERATURE ON THE SEASONAL PREVALENCE OF TYPHOID FEVER.

THE variations in the prevalence of typhoid fever with the changing seasons was one of the characteristics of that remarkable disease which struck the very earliest observers. Elisha Bartlett, in 1842,⁽⁸⁷⁾ wrote of it as follows: "It is not settled whether typhoid fever occurs, with any degree of uniformity, more frequently in one season of the year than in another. . . . I am sure, however, that, as a general rule, its annual prevalence is greatest in the autumn. In New England it is not unfrequently called the autumnal or fall fever."

Dr. Flint, in 1855,⁽⁸⁸⁾ pointed out as one of the points of distinction between typhus and typhoid fever that while the former is unaffected by season, the latter "manifests a predilection for the autumnal months, although it is by no means restricted in its occurrence to the latter." Griesinger, a little later,⁽⁸⁹⁾ noted that in middle Europe and North America the majority of cases as well as the epidemic outbreaks occurred most abundantly in autumn, and that the winter typhoid stood next in relative intensity, followed by that of summer, while the fewest cases occurred in the spring. He quoted Lombard as authority for the fact that in Geneva the month of October shows seven times as many typhoid cases as the month of March. In 1860, Dr. Tweedie⁽⁹⁰⁾ published a table of the admissions of the different forms of continued fever into the London Fever Hospital for ten years and brought out an interesting contrast between typhoid and typhus fevers. His monthly figures for typhoid were as follows:—

| J | F | M | A | M | J | J | A | S | O | N | D |
|-----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|
| 113 | 85 | 77 | 60 | 79 | 119 | 157 | 233 | 260 | 253 | 223 | 161 |

By quarters the difference between the two forms of fever, then just beginning to be clearly distinguished, was shown very markedly.

QUARTERLY ADMISSIONS.

| | Typhus Fever. | Typhoid Fever. |
|-------------------------|---------------|----------------|
| First Quarter | 1074 | 275 |
| Second " | 1088 | 258 |
| Third " | 725 | 650 |
| Fourth " | 619 | 637 |

Dr. Tweedie concluded that "typhus is most prevalent in spring, and the least so in autumn, while enteric fever is least prevalent in spring, and most prevalent in autumn." In the same year, Hirsch, in the first edition of the "*Historisch-geographischen Pathologie*,"⁽⁹²⁾ gave an extensive résumé of current opinion on the subject. He quoted statistics to show that of 519 typhoid epidemics, 168 occurred in autumn, 140 in winter, 132 in summer, and only 79 in spring. He also printed a table of typhoid cases at the hospitals of Lausanne and Geneva, in Lowell and Nassau, and of typhoid deaths in the canton of Geneva and the State of Massachusetts, showing an autumn maximum and a spring minimum in every case. Summer occupied the second place except at Nassau and the canton of Geneva. As to the weather influences controlling this prevalence of the disease he quoted very conflicting opinions. While Drake and Huss attributed the autumnal fever largely to the summer temperature, Davidson and Lombard considered a relatively high humidity as of prime significance. Thomson maintained that both factors were of importance, and Seitz, Cless, and Franque denied any effect of meteorological conditions. Another review of the seasonal variations of typhoid fever was published by Murchison in 1862.⁽⁹³⁾ He quoted nine English and continental authorities as recording the autumnal maximum, and added a table of the admissions into the London Fever Hospital which showed a steady rise from April to October. Fiedler, in the same year,⁽⁹⁴⁾ noted that typhoid fever in Dresden was much more abundant in the second half of the year than in the first, and gave the following table of typhoid admissions for eleven years.

ADMISSIONS TO THE DRESDEN HOSPITAL, 1850-60.

| J | F | M | A | M | J | J | A | S | O | N | D |
|-----|----|-----|----|----|-----|-----|-----|-----|-----|-----|-----|
| 123 | 76 | 114 | 82 | 83 | 105 | 113 | 191 | 189 | 132 | 143 | 146 |

The first systematic attempt to show a relation between typhoid fever and definite meteorological conditions was made by Haller in 1860.⁽⁹¹⁾ This author maintained that the seasonal curve of typhoid corresponded to that of air pressure, and that the greatest prevalence was at periods of low temperature, noting, in that connection, the alleged fact that typhoid fever does not occur autochthonously south of the isotherm of 22° C. Haller's results, however, were not confirmed by other observers; and a new theory as to the ætiology of typhoid fever soon took almost complete possession of the field. This was the famous ground-water theory of Pettenkofer and the Munich school. As applied to typhoid fever this theory was launched by Ludwig Buhl in the first article of the first number of the "*Zeitschrift für Biologie*."⁽⁹⁵⁾ The author dealt with eight hundred and ninety-nine typhoid deaths in a Munich hospital during the period 1855–64, and compared, by the graphic method, the monthly and yearly variations with the changes in temperature, precipitation, and ground-water level. The seasonal curve showed a maximum between December and March, culminating in February, and a minimum in August and October. These monthly variations, and the fluctuations from year to year, did not correspond to the temperature or the precipitation, but did show a certain inverse relation to the height of the ground water.

Seidel⁽⁹⁶⁾ analyzed the figures given by Buhl in a more elaborate manner. He compared for each of the one hundred and eight months, from 1856 to 1864, the typhoid cases and the ground-water level, using in each case the difference between the value for the individual month and the average value for that month during the whole period. In 73.5 cases an excess of typhoid fever corresponded with an excessive fall of the ground water, and in 34.5 cases the reverse relation obtained. Seidel estimated the probability of this preponderance being due to chance alone as one to thirty-six thousand. His monthly averages for morbidity are as follows:—

TYPHOID CASES. MUNICH HOSPITAL. AVERAGE, 1856–64.

| J | F | M | A | M | J | J | A | S | O | N | D |
|------|------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| 14.1 | 12.0 | 6.9 | 5.2 | 5.2 | 6.0 | 4.8 | 6.8 | 4.2 | 7.6 | 12.2 | 13.1 |

In the next year, Seidel⁽⁹⁷⁾ analyzed Buhl's figures in relation to the monthly precipitation, again excluding any difference of season per se, by using only the differences between the value for a month and the average value for the same month

during the nine years considered. He demonstrated a certain inverse relation between an excess of precipitation and the prevalence of typhoid fever just as in the case of the variation in ground-water level, and considered both factors as of importance. Of the fifty-six months in which precipitation and ground-water level varied in the same sense, forty-six showed a variation of typhoid morbidity in the opposite sense.

The studies relating to the cases at the Munich Hospital were extended to the whole city by Pettenkofer in 1868.⁽⁹⁹⁾ He reproduced a chart prepared by F. Wagus, which gives by months the typhoid mortality for the whole city from 1850 to 1867 in comparison with the precipitation and the height of the ground water. The seasonal distribution of the disease coincided with that observed at the hospital, the average number of typhoid deaths for the whole city being as follows : —

| J | F | M | A | M | J | J | A | S | O | N | D |
|------|------|------|------|------|------|------|------|------|------|------|------|
| 33.5 | 36.8 | 31.8 | 23.1 | 17.6 | 15.2 | 15.8 | 16.7 | 16.1 | 15.0 | 19.0 | 28.5 |

A long series of polemical papers on the relation of typhoid, and more particularly of cholera, to the ground water was contributed by Pettenkofer to the "*Archiv für Hygiene*" and the "*Zeitschrift für Biologie*," and his conclusions were finally summarized in pamphlet form.^{(115), (118)} For a time the theories of the Munich school appeared to hold the field. Virchow⁽¹⁰¹⁾ studied the typhoid mortality in Berlin for the period 1854–71, and concluded that there was a striking inverse relation with the ground-water level. Virchow and Guttstadt⁽¹¹⁴⁾ published curves for Berlin from 1883 to 1885, which showed a direct relation to the temperature and an inverse relation to the ground-water level. Finally, a most elaborate presentation of the facts was made by Dr. Soyka in 1887.⁽¹¹⁷⁾ Like his confrères, this author rested his case in large part on the variations in the intensity of the disease and the height of the ground water from year to year; but he also treated of the seasonal variations at some length. Although his table of the monthly distribution of the disease in seventeen cities, reproduced below, showed an autumnal maximum in all but four cases, he considered that these exceptions, Augsburg, Munich, Prague, and Vienna, proved the temperature relation to be an indirect one.

PERCENTAGE MONTHLY DISTRIBUTION OF TYPHOID.

After Soyka.

| Place. | Period. | Total No. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|----------------------------|---------|-----------|------|------|------|------|------|-----|------|------|------|------|------|------|
| Berlin | 1854-85 | 16660 | 6.5 | 6.0 | 5.4 | 5.9 | 5.9 | 5.6 | 8.1 | 11.0 | 12.6 | 13.5 | 10.6 | 8.2 |
| Neufchatel } Lausanne } | 1835-52 | 933 | 8.6 | 5.2 | 5.5 | 2.6 | 4.0 | 6.1 | 7.7 | 10.1 | 13.4 | 17.0 | 9.8 | 9.4 |
| Breslau | 1863-78 | 2521 | 7.7 | 7.5 | 7.5 | 6.4 | 6.1 | 7.4 | 8.5 | 9.6 | 11.3 | 10.5 | 8.7 | 8.0 |
| Frankfort-a-M. | 1853-85 | 1496 | 7.9 | 7.1 | 6.2 | 5.6 | 5.8 | 6.2 | 8.4 | 10.6 | 11.8 | 12.1 | 9.0 | 8.7 |
| Hanover | 1874-85 | 397 | 7.6 | 5.1 | 6.4 | 6.1 | 10.0 | 7.4 | 5.0 | 9.1 | 12.1 | 13.6 | 9.6 | 8.0 |
| Basel | 1826-73 | 2213 | 8.6 | 6.4 | 6.1 | 5.4 | 7.2 | 7.6 | 8.4 | 9.1 | 10.7 | 10.7 | 10.6 | 8.7 |
| Paris | 1867-78 | 4152 | 6.2 | 5.7 | 4.6 | 4.9 | 4.2 | 4.9 | 6.9 | 12.3 | 13.4 | 12.5 | 13.5 | 10.3 |
| Augsburg | 1856-78 | 1092 | 11.0 | 6.7 | 8.1 | 5.3 | 5.1 | 5.2 | 7.3 | 8.9 | 9.7 | 9.7 | 10.6 | 10.8 |
| Bern | 1871-80 | 340 | 9.7 | 6.8 | 7.3 | 9.1 | 6.1 | 7.3 | 5.8 | 6.1 | 10.0 | 7.9 | 12.9 | 10.6 |
| Munich | 1851-85 | 7530 | 11.5 | 11.9 | 11.2 | 9.0 | 7.5 | 6.9 | 6.4 | 6.5 | 6.3 | 5.8 | 6.9 | 9.6 |
| Prague | 1873-84 | 998 | 10.5 | 9.9 | 10.2 | 8.5 | 9.3 | 9.6 | 9.8 | 6.9 | 7.1 | 5.0 | 6.2 | 6.8 |
| Vienna | 1871-85 | 4992 | 8.2 | 7.1 | 11.8 | 10.1 | 9.9 | 8.0 | 8.1 | 7.5 | 7.3 | 7.3 | 6.9 | 7.7 |
| Basel * | 1875-85 | 3599 | 10.3 | 7.1 | 8.0 | 6.7 | 8.0 | 8.2 | 10.1 | 14.8 | 8.6 | 6.9 | 5.7 | 4.9 |
| Leipzig * | 1851-65 | 1052 | 9.4 | 5.7 | 5.1 | 4.3 | 3.8 | 6.0 | 9.3 | 13.0 | 12.9 | 13.2 | 9.4 | 7.2 |
| Copenhagen * | 1842-58 | 3198 | 6.1 | 3.3 | 3.2 | 2.8 | 3.1 | 5.0 | 7.9 | 13.3 | 18.3 | 16.4 | 9.9 | 10.2 |
| Bremen * | 1872-84 | 1648 | 7.6 | 7.0 | 6.6 | 4.8 | 4.9 | 4.7 | 8.1 | 9.6 | 13.8 | 16.3 | 9.1 | 7.0 |
| Chemnitz * | 1838-82 | 1455 | 6.2 | 6.4 | 7.3 | 5.2 | 5.1 | 6.9 | 7.4 | 9.3 | 13.2 | 13.2 | 10.8 | 8.0 |
| Christiania * | 1845-64 | 4550 | 11.3 | 7.3 | 6.1 | 4.3 | 4.0 | 3.3 | 6.1 | 8.8 | 8.6 | 9.6 | 16.8 | 13.2 |

* Morbidity. Other figures refer to mortality.

Soyka finally plotted the typhoid fever and ground-water level in Berlin, Frankfort, Bremen, and Munich, and obtained quite regular complementary curves. His final conclusion was that "the rhythm of typhus abdominalis is in general the inverted rhythm of the ground-water fluctuations."

Unfortunately other researches did not harmonize with these results. Socin at Basle⁽¹⁰⁰⁾ and Fodor at Buda-Pesth⁽¹¹⁰⁾ found quite different relations between typhoid and ground-water level. Later examinations of the yearly variations, even in Munich, failed to show the correspondence noted prior to 1881. Most potent of all, however, in overthrowing the ground-water theory was the gradual substitution of zymotic for miasmatic conceptions of disease which robbed it of any rational, ætiological basis.

The only plausible explanation of the connection between ground water and typhoid fever, on the basis of the germ theory, had been furnished by Liebermeister,⁽⁹⁸⁾ who suggested in 1860 that the phenomena observed by Buhl might simply be due to the concentration of soil impurities in wells at the time of low water and their transmission in unusually large doses to those who drank therefrom. A simple modification of Liebermeister's idea, including a recognition of the fact that a well in use drains a wider area when the ground water is low and is thus liable to pollution from more distant sources, has been strongly advocated in this country by Dr. H. B. Baker of Michigan. As early as 1878 Dr. Baker⁽¹⁰⁸⁾ published curves showing the

seasonal distribution of the more important diseases, and pointed out the contrast between such diseases as bronchitis, pneumonia, and croup which culminate in the winter and the fevers and diarrhoeal diseases which attain a maximum in the hot months. His curves showed a slight rise in October for typhoid fever and much more marked rises for the classes of "Typho-malarial," "Remittent," and "Intermittent" fevers, the figures for which in absolute value greatly exceeded those for the former disease. Similar tables were published in the succeeding annual reports; and in 1882 it was stated that "more than the average per cent of weekly reports stated the presence of typhoid fever in months when the average daily temperature, the average daily range of temperature, the absolute humidity of the atmosphere, the monthly and the average daily range of the barometer and the average daily pressure of the atmosphere were greater than the average for the year; and less than the average per cent of reports stated the presence of typhoid fever in months when these conditions were less than the average for the year." These curves and conclusions have been repeated year by year in each annual report, the only change being the gradual increase of "typhoid fever" relative to the "typho-malarial" and "remittent" fevers with improvement in diagnosis. In 1884, Dr. Baker⁽¹¹³⁾ treated typhoid fever in more detail, comparing the seasonal variations of the disease for five years with the height of the ground water in Michigan and showing that the disease increased quite regularly with the number of inches of earth above the water in the wells. He concluded that "in summer when vegetation is active and not decaying, a lowering of the water is uniformly followed by increased prevalence of typhoid fever; with the advent of colder weather there is a rise in the water level which is uniformly followed by a decreased prevalence of the fever; that this decrease continues through the winter and spring even though the level of the well water is lowered, provided the surface of the earth is deeply frozen; that on the contrary high-water level in wells in winter and spring coincident with ground not thoroughly frozen is followed by increased prevalence of the fever."

The relation to ground water was again studied in the Report of the Michigan State Board of Health for 1888 (p. lv.), and 1890 (p. 247); and in the Report for 1894 (p. 300) and succeeding reports, new diagrams were published and the following conclusions were added: "The evidence is conclusive that there is a necessary relation between the low water in wells and the sickness from typhoid fever. The fluctuations in the sickness from typhoid fever and the depth of the water in wells are nearly coincident throughout the several months. The maximum of sickness and the minimum of water are coincident in October." Finally, in 1897, Dr. Baker⁽¹²⁸⁾

printed a new diagram exhibiting the curves of typhoid fever and ground water for fourteen years, and suggested in support of his explanation of the inverse relation shown that another factor of less universal importance than the pollution of wells by distant privies might be the infection of air, food, and drink by germs blown from the surface of the ground, which must be dryer and more exposed to such action when the ground water is low.

Dr. Baker's theory regarding the pollution of wells at times of low water seems quite insufficient to account for such a universal phenomenon as the autumnal maximum of typhoid fever, even with the additional suggestion as to air contagion. Well water is by no means the most important source of the disease; and even as to wells the theory does not take all the facts into account. Other observers have attempted to trace with some success an almost exactly opposite relation between typhoid fever and excessive precipitation. Dr. F. H. Welch,⁽¹¹¹⁾ for example, who noted that the maximum of typhoid fever occurred in the last quarter of the year in Malta and in Bermuda, in the latter half of the year at Gibraltar, during the autumnal months, — from March to May, — at the Cape of Good Hope, and in the warm season in India, finally concluded that “the great natural assistant (in the spread of the disease) is the rainfall in giving moisture for growth and putrefaction, in causing water circulation on the surface and in the subsoil, in its mechanical removal of material from drains and hidden receptacles.”

Whatever the explanation, it seems to be proven that at Munich in the period studied by Pettenkofer and his followers a real relation did exist between ground-water level and typhoid. In no other case, as far as we are aware, has another factor been excluded which normally varies inversely with the ground-water level and which does bear a plausible relation to the distribution of the typhoid germ. This factor is the temperature; and the seasonal curve in many places, Michigan, for example, and Berlin, can be more satisfactorily explained by a direct relation to the temperature than by an inverse relation to the ground-water level. The first author forcibly to call attention to the importance of the temperature factor was Murchison. In the second edition of his work on the continued fevers,⁽¹⁰²⁾ he gave a table of the monthly admissions into the London Fever Hospital from 1848 to 1870, of which the totals were as follows: —

| J | F | M | A | M | J | J | A | S | O | N | D |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 433 | 306 | 318 | 209 | 232 | 335 | 434 | 721 | 803 | 839 | 819 | 539 |

Murchison pointed out that a "great increase of enteric fever in the autumn months was observed in each of the twenty-three years, with one noteworthy exception (1860)." He also noted that the autumnal increase did not subside immediately on the advent of winter, and concluded that "it would seem as if the cause of the disease were only exaggerated or called into action by the protracted heat of summer and autumn, and that it required the protracted cold of winter and spring to impair its activity or to destroy it."

He quoted numerous observers, Todd and Burne in England, Stewart in Scotland, Lombard and Rilliet and Barthez in Switzerland, Piedvache, de Claubry and Druher in France, Forget and Quincke in Germany, and Bartlett, Wood, and Flint in the United States, as recording the autumnal character of the disease. Finally he added, "Not only does enteric fever increase in autumn, but it has been found to be unusually prevalent after summers remarkable for their dryness and high temperature, and to be unusually rare in summers and autumns which are cold and wet." The references to the early authorities quoted by Murchison will be found in his elaborate bibliography.

Liebermeister also had a clear conception of the possible effect of temperature upon the prevalence of typhoid fever. In his article on typhoid fever in Ziemssen's *Cyclopedia*,⁽¹⁰³⁾ he plotted the monthly deaths in Berlin and hospital admissions in London and Basle, compared with curves of the monthly variations in temperature, and commented on the results as follows: "The general bearing of these curves is evident. The curves representing the frequency of typhoid correspond to the curves of average temperature, only with this difference. The different points of the typhoid curve follow those of the temperature curve by an interval of some months. The minimum of temperature falls in January, that of typhoid in February or April; the maximum of temperature falls in July, that of typhoid in September and October. It appears, therefore, that the development and spread of typhoid fever is favored by the high summer temperature and checked by the low winter temperature. The interval of two or three months between the temperature and the typhoid curves correspond to the time which is necessary for the changes of temperature to penetrate to the places where the typhoid poison is elaborated, for the development of the poison without the human body, for the period of incubation, and for the time between the commencement of the attack and that of the patient's admission to the hospital, or that of his death."

Cousot,⁽¹⁰⁴⁾ in France, about the same time, noted that the month of October always showed a maximum of typhoid, that the intensity then diminished till spring, and

that the summer was marked by unimportant oscillations. This influence of the season he attributed to the effect of temperature and moisture, and he concluded that a moderate temperature accompanied by humidity furnished the conditions most favorable for the spread of the disease. Further evidence was contributed by Buchan and Mitchell,⁽¹⁰⁶⁾ who tabulated deaths by weeks from all causes distinguished by the Registrar-General in London, for thirty years, 1845–74, and for each disease plotted a curve showing the average weekly deviation from the general weekly mean. For typhoid fever only the six years, 1869–74, were available as prior to 1869 typhus, typhoid and continued fevers were not distinguished. The curve showed a maximum in October and November and a minimum from the middle of May to the end of June, the rise beginning only at the beginning of July, “when the heat of summer has fairly set in.”

Pistor,⁽¹¹⁶⁾ who compared the typhoid cases and deaths for 1883–85 in Berlin, with the height of the ground water and of the river Spree, the precipitation, the height of the barometer, and the temperature of the air and the earth, differed from Virchow and Guttstadt (see above) in finding no marked correspondence with the ground-water variations. As regards temperature, he concluded that “typhoid is in general more abundant in the hot months than in the cold; it appears, however, that mild and damp spring, autumn, and even winter months favor its spread, although not in the same degree as the hot season.” Almquist,⁽¹¹⁹⁾ who studied in detail the seasonal prevalence of fourteen diseases in Göteborg, concluded with regard to typhoid fever that an annual increase in summer or autumn is characteristic, but that this increase is sometimes postponed till the end of the year or the beginning of the next year. A second maximum in January is sometimes combined with the summer maximum. Dryness and the variation in the ground-water level, and above all the warmth in summer and autumn, appeared to him to be operative. Goldberg,⁽¹²⁰⁾ in 1889, made an elaborate study of the seasonal prevalence of a large number of diseases in relation to various meteorological conditions, and arrived at the conclusion that the weather influences the mortality from the infectious diseases both by its effect on the multiplication of the germs and their facilities for entrance into the body and by its effect on the vital resistance of the human body in its reaction against the invading organisms. With regard to typhoid fever he analyzed the statistics for Berlin, Hamburg, and Cologne, and summed up his results as follows:—

A. As regards individual disposition, the extremes of air temperature weaken the resistance against typhoid.

B. As regards time-and-place disposition :

1. The rise of typhoid morbidity and mortality in Berlin regularly follows the rise in the temperature of the earth one-half to one meter below the surface.

2. The very different annual periods and annual variations in Berlin, Hamburg, and Cologne correspond throughout to the rhythm of the movements of the ground water.

3. The distribution of rainfall in Berlin and Hamburg, if allowance be made for evaporation, explains satisfactorily the variations both in the height of the ground water and the frequency of typhoid fever.

Goldberg noted what so many other observers have failed to consider that not only the temperature of a given month but also the course of the temperature curve during the months immediately preceding, must be considered; thus the same mean monthly temperature in May and October need not correspond to the same amount of typhoid. He saw that a high temperature favored the spread of typhoid fever, and believed that this was due to a lowering of the vital resistance of the human body by extremes of temperature.

The most important evidence bearing upon the relation of heat to the prevalence of typhoid fever was that collected by Davidson in his "Geographical Pathology," published in 1892.⁽¹²²⁾ This author strongly emphasized the seasonal character of the disease and considered the temperature to be the one factor of prime importance. He stated that in South Australia, Victoria, and New South Wales typhoid attains its maximum in the autumn months of March, April, and May, and its minimum in September, October, and November. In Queensland the maximum seems to fall upon the hot season, from November to February. For India, he concluded that in the Bengal Presidency the disease attains its maximum in the second quarter and in Central India, Bombay, and Madras in the third quarter. In considering England and Germany, he mentioned the usual autumnal maximum; and for several countries as quoted below, he gave specific figures as to monthly prevalence.

MONTHLY PREVALENCE OF TYPHOID FEVER.

Compiled from figures given by Davidson.

| Place. | Period. | Number of Cases. | Monthly Percentage of Total for Year. | | | | | | | | | | | |
|-------------------|-------------|------------------|---------------------------------------|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| | | | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
| Finland | 1889 | 639 | 3.1 | 4.2 | 2.8 | 2.7 | 5.3 | 3.1 | 11.9 | 20.5 | 11.7 | 12.4 | 13.6 | 8.6 |
| France | 1868-78 | — | 6.2 | 5.7 | 4.6 | 4.9 | 4.2 | 4.9 | 6.9 | 12.3 | 13.5 | 12.5 | 13.6 | 10.3 |
| (Paris) | | | | | | | | | | | | | | |
| France | 1886-87 | — | 6.7 | 4.2 | 4.4 | 4.5 | 6.5 | 7.0 | 10.4 | 14.6 | 14.6 | 11.0 | 8.2 | 7.8 |
| (Marseilles) | | | | | | | | | | | | | | |
| Italy | three years | — | 6.7 | 6.5 | 6.8 | 7.2 | 7.3 | 7.2 | 9.4 | 11.2 | 11.1 | 10.6 | 8.6 | 7.4 |
| Norway | 1886-87 | 3138 | 11.3 | 7.3 | 8.9 | 8.4 | 5.8 | 6.1 | 7.0 | 8.1 | 9.5 | 10.5 | 8.7 | 8.4 |
| Scotland | 1876-85 | 3548 | 8.5 | 7.7 | 7.4 | 7.4 | 8.8 | 7.4 | 5.9 | 7.4 | 9.6 | 11.7 | 8.7 | 9.4 |
| (principal towns) | | | | | | | | | | | | | | |
| Sweden | 1886-87 | 10743 | 8.9 | 6.5 | 6.8 | 5.9 | 6.3 | 5.7 | 8.1 | 10.3 | 11.5 | 10.0 | 11.2 | 8.7 |

Davidson also attempted to show the causal relation between typhoid fever and temperature variations from year to year after the method adopted by Soyka in treating of the ground-water theory. In the case of New South Wales he took the figures for the period 1877–87, with a mean summer temperature (December to February) of 71.14 F., and a mean typhoid death rate of 5.02 per 10,000, and divided them to form the two following tables.

SIX YEARS WITH TEMPERATURE AND TYPHOID RATE ABOVE THE MEAN FOR THE WHOLE PERIOD.

| | 1877. | 1878. | 1882. | 1884. | 1885. | 1886. |
|-------------------------|-------|-------|-------|-------|-------|-------|
| Mean Summer Temperature | 71.40 | 72.00 | 71.17 | 71.47 | 71.87 | 72.10 |
| Mean Typhoid Death Rate | 5.96 | 6.70 | 5.66 | 5.86 | 5.40 | 6.03 |

FIVE YEARS WITH TEMPERATURE AND TYPHOID RATE BELOW THE MEAN FOR THE WHOLE PERIOD.

| | 1879. | 1880. | 1881. | 1883. | 1887. |
|-------------------------|-------|-------|-------|-------|-------|
| Mean Summer Temperature | 71.00 | 70.17 | 70.03 | 70.07 | 71.10 |
| Mean Typhoid Death Rate | 3.84 | 3.31 | 3.50 | 4.76 | 4.24 |

Again, in the case of England, Davidson separated from the period 1863–87, four years in which enteric fever was unusually prevalent, and five years which were remarkably free from that disease, and tabulated the relative mean temperatures for those years as follows:—

| Four Years with Maximum Typhoid. | | | Five Years with Minimum Typhoid. | | |
|----------------------------------|---------------------------------------------------------------|------------------------|----------------------------------|---------------------------------------------------------------|------------------------|
| Year. | Difference between Temperature and Mean Temperature, 1863–87. | | Year. | Difference between Temperature and Mean Temperature, 1863–87. | |
| | For the Year. | For the Third Quarter. | | For the Year. | For the Third Quarter. |
| 1865 | +1.0 | +2.1 | 1867 | −0.7 | −0.7 |
| 1878 | +0.3 | +0.4 | 1877 | +0.1 | −1.9 |
| 1880 | +0.1 | +1.0 | 1879 | −3.1 | −2.3 |
| 1884 | +1.4 | +2.3 | 1881 | −0.6 | −0.4 |
| | | | 1885 | −0.7 | −1.3 |

These investigations of the yearly variations in typhoid fever are of considerable interest and should be extended; but the differences shown by Davidson are so small and the material so limited as to preclude the drawing of any general conclusions.

The clearest and most definite statement of the effect of temperature upon the spread of typhoid fever that we have seen was made by Professor Woodhead in testifying before the Royal Commission on Metropolitan Water Supply in 1893.⁽¹²³⁾ Having spoken of the importance of spring floods in carrying infection into

water-supplies, he was asked why the maximum of typhoid occurred in autumn instead of at the time of the greatest floods, and his reply was as follows:—

“You were speaking just now of the conditions under which the typhoid bacillus develops, and you were speaking of it as being a pathogenic organism, and therefore as not competing on equal terms with the saprophytic organisms; and here the matter of temperature alone plays such a very important part that it cannot be left out of consideration. Although you have in February the highest point of floods, you have the temperature so low that the typhoid bacillus could scarcely develop under any conditions, whereas when you come to August, when the temperature is much nearer that of the body, that is, the temperature under which the typhoid bacillus can exist, then the conditions become so much more favorable that the organism can live more readily, more easily, and become more virulent outside the body than it can when the temperature is put very much lower, and, therefore, although at flood times the highest flood points one would expect (if you leave out the temperature) the typhoid bacillus to do the greatest amount of damage, still the temperature is so low that the presence of the bacillus is practically a matter of no importance at that period, and it is only when you get to the flood periods when the temperature is higher that you can take these statistics as bearing on the point. But beyond this, should there be a sporadic case of typhoid due to the use of contaminated water, the conditions for the propagation of the disease are not nearly so favorable during the cold months of February as they are in the hotter months of the year, and therefore the health returns and the tables would be much less affected, not only at the time of the primary outbreak but for some little time afterwards.”

Plausible as the conclusions of Murchison, Davidson, and Woodhead appear, they have not gained wide acceptance, and in Germany have been utterly ignored, except by Liebermeister in the passage quoted above. In the same year that his statement appeared, Oesterlen⁽¹⁰⁵⁾ published some figures on the quarterly prevalence of typhoid as given below, and concluded: “That temperature exerts no, or at least a very secondary, influence, is obvious from the very small difference which often appears between the different seasons, and from the circumstance that typhoid epidemics may arise and culminate at the extremes of temperature, in great cold as well as great heat.”

QUARTERLY PREVALENCE OF TYPHOID.

After Oesterlen.

| Place. | Period. | Winter. | Spring. | Summer. | Autumn. |
|---------------------------------------|---------|---------|---------|---------|---------|
| Geneva | — | 180 | 109 | 105 | 203 |
| London | 1849-53 | 2813 | 2527 | 2916 | 3305 |
| Nassau | 1818-56 | 670 | 470 | 486 | 863 |
| Massachusetts | 1845-49 | 429 | 259 | 528 | 1132 |
| Lowell | 1840-47 | 130 | 102 | 163 | 250 |
| Berlin (average monthly deaths) . . . | 1830-38 | 27 | 18 | 23 | 41 |

A little later, Sander⁽¹⁰⁷⁾ gave a table showing the quarterly distribution of typhoid fever in Berlin, Munich, Halle, Hamburg, Schleswig-Holstein, Dresden, Leipsic, and Chemnitz, and stated that the winter in Munich and the autumn in most other places is the period of special incidence, while May and June are always the months which are most exempt. In 1881, Oldendorff⁽¹⁰⁹⁾ published a few figures as to quarterly prevalence, and repeated Oesterlen's conclusion as to the limited importance of the temperature factor.

In the second edition of the "Geographical and Historical Pathology,"⁽¹¹²⁾ Hirsch devoted considerable space to a consideration of the meteorological factors affecting the spread of typhoid fever. He quoted first numerous earlier observers, to whom references are given in his bibliography. Zülzer at Berlin and Trier at Copenhagen thought that hot and dry weather favored the disease, while others held a wet summer to be a contributory cause. Schiefferdecker at Königsberg, Pribram and Popper at Prague, and Jacoby at Breslau believed they had traced a connection between typhoid and the ground-water level. Hirsch then gave the very valuable tables of seasonal prevalence reproduced below, and in comment remarked, "The result obtained from these tables, that the amount of the sickness touches its highest point in autumn, is fully borne out by the facts as to the season of greatest prevalence of typhoid in many other localities." He cited Schwerin, Bremen, Iceland, Malta, Italy, the Cape, Greenland, and Newfoundland; and added, "All the more noteworthy is the circumstance that, in tropical and subtropical regions, it is chiefly the hot months that form the typhoid season," quoting Algiers, Tunis, Japan, India, Cochin China, Bermuda, and Cuba. An analysis of the typhoid statistics of Berlin from 1871 to 1878 failed to show any correspondence between the amount of typhoid in any given year and the excess of temperature compared with the mean for the whole period; and the author concluded his consideration of the subject as follows: "That no special importance in this connection can be ascribed to the temperature of the air — high or low — *by itself*, follows from the fact that the acme of the disease falls variously in various regions within higher latitudes, either in autumn or in winter; while, in the tropics, it falls mostly at the time of the greatest heats."

MONTHLY DISTRIBUTION OF TYPHOID FEVER.

After Hirsch.

| Place. | Period. | Months. | | | | | | | | | | | |
|----------------------------|---------|---------|------|------|------|------|------|------|------|------|------|------|-----|
| | | J. | J. | A. | S. | O. | N. | D. | J. | F. | M. | A. | M. |
| Christiania * | 1845-64 | 154 | 281 | 402 | 393 | 437 | 768 | 602 | 517 | 335 | 283 | 196 | 182 |
| Drammen * | 1861-67 | 46 | 100 | 149 | 180 | 253 | 251 | 202 | 141 | 92 | 88 | 56 | 55 |
| Copenhagen * | 1842-58 | 162 | 254 | 428 | 588 | 526 | 317 | 328 | 195 | 105 | 103 | 92 | 100 |
| Hamburg . . | 1873-80 | 82 | 82 | 122 | 116 | 147 | 127 | 158 | 146 | 149 | 125 | 90 | 102 |
| Berlin . . . | 1854-79 | 850 | 1159 | 1616 | 1879 | 1965 | 1540 | 1184 | 997 | 919 | 854 | 921 | 910 |
| Breslau . . . | 1863-78 | 187 | 215 | 244 | 287 | 267 | 220 | 202 | 197 | 192 | 192 | 164 | 154 |
| Leipzig * | 1851-65 | 64 | 98 | 137 | 135 | 144 | 99 | 76 | 100 | 60 | 54 | 44 | 41 |
| Chemnitz * | 1837-75 | 171 | 208 | 303 | 300 | 245 | 185 | 241 | 148 | 166 | 121 | 112 | 154 |
| Prague * | 1874-76 | 78 | 90 | 69 | 79 | 76 | 84 | 115 | 191 | 122 | 119 | 106 | 110 |
| Nassau * | 1818-59 | 1118 | 1406 | 1742 | 2093 | 2350 | 2207 | 1946 | 1850 | 1584 | 1428 | 1060 | 848 |
| Frankfort-a-M. | 1863-80 | 52 | 74 | 91 | 106 | 113 | 93 | 76 | 60 | 58 | 50 | 50 | 43 |
| Stuttgart . . | 1852-77 | 69 | 76 | 83 | 87 | 88 | 108 | 122 | 106 | 84 | 90 | 73 | 66 |
| Munich . . . | 1852-68 | 408 | 377 | 379 | 365 | 363 | 425 | 619 | 718 | 783 | 699 | 548 | 444 |
| Neufchatel } Lausanne } | 1873-79 | | | | | | | | | | | | |
| Basel . . . | 1835-52 | 57 | 72 | 95 | 125 | 159 | 92 | 88 | 81 | 49 | 52 | 25 | 38 |
| London * | 1824-73 | 169 | 186 | 202 | 237 | 237 | 236 | 193 | 192 | 143 | 137 | 121 | 160 |
| Glasgow * | 1848-62 | 163 | 220 | 333 | 361 | 377 | 334 | 222 | 197 | 122 | 136 | 89 | 103 |
| Paris . . . | 1871-79 | 12 | 15 | 30 | 43 | 36 | 31 | 20 | 23 | 18 | 29 | 18 | 17 |
| Boston * | 1867-78 | 205 | 289 | 511 | 559 | 522 | 565 | 429 | 259 | 240 | 192 | 205 | 176 |
| Pittsburg . . | 1840-47 | 30 | 47 | 86 | 92 | 98 | 60 | 48 | 39 | 43 | 40 | 21 | 41 |
| | 1873-77 | 27 | 32 | 65 | 64 | 90 | 65 | 52 | 53 | 37 | 43 | 44 | 53 |

* Hospital admissions. Other figures refer to reported deaths.

SEASONAL RATIO OF TYPHOID.

After Hirsch.

| Place. | Autumn. | Winter. | Summer. | Place. | Autumn. | Winter. | Summer. |
|-------------------|---------|---------|---------|------------------|---------|---------|---------|
| Copenhagen . . | 4.9 | 2.1 | 2.9 | Geneva | 1.9 | 1.7 | 1.0 |
| Drammen . . . | 3.4 | 2.2 | 1.5 | Chemnitz . . . | 1.9 | 1.4 | 1.8 |
| Lausanne . . . | 3.3 | 1.9 | 1.9 | Basel | 1.7 | 1.3 | 1.3 |
| London | 3.2 | 1.7 | 2.2 | Glasgow | 1.7 | .9 | .9 |
| Paris | 2.9 | 1.6 | 1.8 | Pittsburg . . . | 1.5 | 1.0 | .9 |
| Massachusetts . | 2.8 | 1.3 | 1.6 | Breslau | 1.5 | 1.2 | 1.3 |
| Leipzig | 2.7 | 1.7 | 2.1 | Sweden | 1.2 | 1.2 | 1.1 |
| Christiania . . . | 2.4 | 2.2 | 1.3 | Hamburg | 1.2 | 1.3 | .9 |
| Boston | 2.4 | 1.2 | 1.6 | Stuttgart . . . | 1.2 | 1.3 | 1.0 |
| Frankfort-a-M. . | 2.2 | 1.3 | 1.5 | Munich | .7 | 1.3 | .7 |
| Berlin | 2.0 | 1.2 | 1.4 | Prague | .7 | 1.3 | .7 |
| Nassau | 2.0 | 1.6 | 1.3 | | | | |

These ratios refer to a value of 1 for the Spring Typhoid. Spring is considered to begin with March.

The work which has been done upon the seasonal prevalence of typhoid fever within the last ten years has, if anything, only made the subject more obscure. Magelssen, in his classic brochure⁽¹²¹⁾ on the dependence of diseases upon the weather, in which he showed so clearly the unfavorable influence of extreme low temperatures upon the general mortality, only alluded to typhoid in passing, stating that it is most abundant in the latter months of the year. Körösi, in 1894,⁽¹²⁴⁾ made an elaborate comparison of the reported cases of the infectious diseases in Berlin with the moisture and temperature by periods of five days, a week and a month, according to the incubation period of the disease. He criticised those observers, especially Haller, who have studied the relation of disease to season, in general, on the ground that such a comparison can throw no light on the causation of disease as the phenomena involved are too complex. His method consisted in the division of his pentads and months into five groups, designated as very cold, fairly cold, fairly warm, warm, and hot, and the calculation of the relative prevalence of the disease in each group of periods. He thus eliminated all the effects of the weather preceding the period considered and obscured the facts. When analyzed into his five temperature groups, two maxima appeared, — one in the hot, one in the fairly cold months, — and he concluded that no positive relation is shown. Moisture, on the other hand, appeared to exert an appreciable effect, and he finally concluded that the maximum of morbidity occurred in dry weather with medium warmth, while the minimum was reached when a medium temperature coincided with an excess of moisture. Fodor, in 1896,⁽¹²⁵⁾ declared that “the striking dependence on the warmth, and on the season which is so characteristic of cholera is almost entirely wanting in typhoid fever.” In the same year, Jessen⁽¹²⁶⁾ published curves which showed the monthly prevalence of measles, croup, and diphtheria, typhoid fever, cholera, pneumonia, phthisis, and diarrhoeal diseases of children in comparison with variations in wind, temperature, humidity, and rainfall. With regard to typhoid fever he concluded that temperature was the only factor which affected the disease, and that this was only of slight importance, as typhoid fever, though occurring principally in the cold months (!), sometimes attained a maximum when the temperature was high. Knoevenagel⁽¹²⁷⁾ noted the increased prevalence of typhoid fever in Mecklenburg-Schwerin at the end of July and in August and September. Berger⁽¹²⁹⁾ and Ruhemann,⁽¹³⁰⁾ in 1898, emphasized the importance of atmospheric conditions in ætiology, and criticised the exclusive attention paid to the bacteriological factors in disease. The former author, after an excellent review of literature on the influence of weather on various diseases (tuberculosis, pneumonia), published curves of morbidity from diphtheria, scarlet fever, measles, and typhoid

fever in a rural district for a period of four years. Typhoid fever, although the total number of cases was only twenty-two, showed a maximum in August and a minimum between November and February. Berger concluded that typhoid fever is most prevalent with a falling barometer and a rising thermometer, hygrometer, and dew point, and that its occurrence is favored by damp and cloudy weather. Ruhemann alluded only in passing to typhoid fever, mentioning its summer maximum. Finally, in 1899, Weichselbaum⁽¹³¹⁾ concluded that "no seasonal distribution of typhoid, no preference of that disease for any special time of year, at least in the marked sense in which it has been shown for cholera, has been, or will be demonstrated."*

Curschmann, in the latest monograph on typhoid fever,⁽¹³²⁾ notes that this disease shows a "constant and for many countries a uniform relation to the seasons." "Everywhere the increased frequency occurs during the late summer and autumn months." "The period of least prevalence of typhoid fever is everywhere the spring and the beginning of the summer, especially the months of March, April, and May." He quotes the figures for London (Murchison), Dresden (Fiedler), and the Hamburg epidemic of 1886-87, and gives a table for Leipsic which is reproduced below. The London and Leipsic figures, when plotted, show very regular curves.

CASES OF TYPHOID FEVER RECEIVED INTO JACOBSSPITAL, LEIPSIC, FROM 1880 TO 1892.

| J | F | M | A | M | J | J | A | S | O | N | D |
|-----|----|----|----|----|----|-----|-----|-----|-----|-----|----|
| 122 | 96 | 97 | 78 | 71 | 75 | 136 | 252 | 240 | 193 | 150 | 88 |

In commenting on these facts Curschmann says: "The causes for this remarkable uniformity in the relations of typhoid fever to season are as yet wholly unknown.

* Behrens (*Einfluss der Witterung auf Diphtherie, Scharlach, Masern und Typhus*, *Arch. f. Hyg.*, XL., 1901, 1) has recently published an exhaustive study on the influence of weather on the prevalence of diphtheria, scarlet fever, measles, and typhoid. His method consists in the arrangement of the individual months for a period of five years in classes according to temperature, humidity, and precipitation, and the tabulation of the morbidity and mortality for the various classes of months. The cities treated are Carlsruhe, Berlin, Bremen, and Breslau. A series of tables is appended of morbidity in Carlsruhe from the four diseases treated by five-day periods with an elaborate analysis of the meteorological conditions. The results of the investigation are conflicting and inconclusive. With reference to typhoid fever, Dr. Behrens sums up the evidence from his own work and that of Jessen and Körösi as follows: "Typhoid reaches its maximum in hot weather at Carlsruhe, Berlin, and Breslau, in cold weather at Hamburg, and in weather of medium warmth at Budapest. At Bremen no influence of temperature can be shown. Carlsruhe, Berlin, Breslau, and Budapest agree in the fact that the number of typhoid cases is greatest when the humidity is least; in Bremen, on the other hand, the maximum occurs when the hygrometer is highest. A heavy precipitation and a maximum of rainy days favor the disease in all cases." His final conclusion with regard to this disease is as follows: "Typhoid cases are as numerous with a warmer as with a cooler temperature, but are markedly favored in their occurrence by cloudy and rainy weather."

The universality of the relation, its recurrence in all possible, remotely situated regions, indicate that it is dependent not upon local, but upon general conditions, possibly such as are responsible for the power of multiplication and the vital activity of the typhoid germ itself. Although much is known with regard to the details in this connection, an insight into the solution of general questions is wanting, particularly the relation of the poison to important cosmic conditions. It is, therefore, better for the present to leave a glaring deficiency rather than to bridge it over with unstable theories."

II. STATISTICAL STUDIES BY THE AUTHORS ON SEASONAL VARIATIONS
IN TEMPERATURE AND ON THE PREVALENCE OF TYPHOID
FEVER IN VARIOUS COUNTRIES.

It appears, then, from a review of the literature that, although most observers have noted a characteristic seasonal distribution of typhoid fever, others, including some of those who have written most recently, have denied the existence of such regular variations. Of those who realized that the variations did exist, a few sought an explanation in the factor of temperature. Their views did not, however, gain acceptance, as the evidence furnished was insufficient; and the common view, among medical men and sanitarians, has been that the fall maximum of typhoid fever was an unexplained phenomenon.

The bacteriological work on the effect of low temperatures upon the bacillus of typhoid fever, reported in the first section of this paper, lent force to the idea that the temperature really might in itself exercise a direct effect upon the ætiology of this disease. We therefore determined to see whether the relation shown by Murchison, Liebermeister, and Davidson for a few places could be demonstrated by a more exact examination of statistics collected from a wider field.

We have, accordingly, brought together statistics of the monthly variations in temperature and in the prevalence of typhoid fever for thirty communities, as follows: The States of New York and Massachusetts, the District of Columbia, and the cities of Atlanta, Baltimore, Boston, Charleston, Chicago, Cincinnati, Denver, Mobile, Newark, New Orleans, New York, Oakland, Philadelphia, St. Paul, and San Francisco, in the United States; the city of Montreal in Canada; the cities of Berlin, Dresden, Leipsic, London, Munich, Paris, and Vienna in Europe; the Empire of Japan, and the British Army in India, in Asia; and the cities of Buenos Ayres and Santiago de Chile in South America. Four continents and both hemispheres are thus represented, and a very wide range of climate. (See pp. 540-566.)

The mean monthly temperatures for the American cities were obtained from the reports of the United States Weather Bureau; those for the German cities, from the publications of the astronomical observatories in their respective districts; and those for London, Paris, Montreal, Buenos Ayres, and Santiago from special local publications mentioned in connection with the tables. For the States of New York and Massachusetts, it was assumed that the temperature of New York City and Boston would serve without serious error. For Japan, where the range of temperature is rather wide, an average was taken of the record of ten stations in different parts of the Empire, as given by the Central Meteorological Observatory. In the case of India, it appeared inadvisable to attempt to calculate an average for the whole empire, as the seasons in the different districts are so very different. The typhoid figures are, therefore, compared with two sets of temperature values, for Central India, and for the Punjab, taken from Hann's "*Klimatologie*," which give a fair idea of the two most important meteorological zones. For each of the cities and stations, with one or two exceptions, the figures for ten years have been used in order to secure a reliable average; and the mean monthly temperatures finally obtained have all been reduced to the Fahrenheit scale for uniformity and convenience in plotting the curves.

The typhoid statistics include records of hospital admissions at the two hospitals of Santiago de Chile, of hospital admissions in the British Army in India, of reported cases at Newark and of deaths in all other instances. The figures for the American States and cities, for Montreal, London, and Paris, were obtained from the published reports of the local Departments of Health, supplemented in some cases by information furnished in reply to correspondence; the German statistics were taken from the "*Veröffentlichungen des Kaiserlichen Gesundheitsamtes*;" for Japan, the Annual Reports of the Central Sanitary Bureau, for India, the Parliamentary blue-books, and for the South American cities, local sanitary periodicals referred to in the tables, were consulted. The figures for ten years were averaged in each case except as follows: for Vienna and Japan the period was five years; for Atlanta, six years; for Montreal and New Orleans, eight years; for Denver and Paris, nine years; for the Army in India, eleven years; for Buenos Ayres, twenty-two years. In each case the average number of deaths per month has been reduced to a ratio of one hundred deaths per year, the final figure for each month representing the number that occur in that month for every hundred deaths in the year. Thus the absolute amount of the disease is entirely eliminated, and only its seasonal distribution considered. The value of the statistics will not therefore be impaired by errors of registration, which it may be assumed will not vary from month to month.

Finally, the monthly values for temperature and typhoid prevalence have been plotted on the appended plates in order to show graphically the relation of the two curves. For each locality the abscissæ represent the successive months, and the ordinates the monthly temperature and percentage of annual typhoid. We should not, however, expect the effect of January temperatures to be manifest in the typhoid death-rate until March, as about two months will be taken up in the transfer of the infection to the victim, in the incubation of the disease, and in its course toward a fatal termination. Accordingly, in order to make the relation of the two curves more striking, the typhoid curve has in each case been shifted along to the left by just two months, so that March typhoid comes just above January temperature, and so on. Where cases and not deaths have been considered (Santiago, Newark, India) the curve has been only moved along by one month. This transposition does not, of course, alter the shape of the curves or their relation to each other, but only makes that relation clearer to the eye. (See Plates I.–VIII.)

BOSTON.

MONTHLY TYPHOID DEATHS.

From Reports, Local Department of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| 1888 | 7 | 5 | 5 | 11 | 3 | 11 | 11 | 19 | 31 | 42 | 17 | 18 |
| 1889 | 6 | 7 | 7 | 7 | 9 | 12 | 17 | 35 | 33 | 23 | 17 | 13 |
| 1890 | 7 | 5 | 7 | 7 | 7 | 8 | 9 | 20 | 27 | 20 | 19 | 19 |
| 1891 | 8 | 4 | 11 | 9 | 8 | 4 | 7 | 14 | 29 | 29 | 15 | 16 |
| 1892 | 2 | 5 | 7 | 7 | 9 | 6 | 6 | 15 | 18 | 29 | 18 | 15 |
| 1893 | 13 | 9 | 6 | 10 | 13 | 12 | 7 | 15 | 14 | 26 | 17 | 6 |
| 1894 | 3 | 5 | 5 | 7 | 7 | 4 | 4 | 18 | 30 | 27 | 20 | 11 |
| 1895 | 8 | 3 | 6 | 7 | 11 | 8 | 9 | 26 | 28 | 26 | 13 | 18 |
| 1896 | 14 | 6 | 2 | 5 | 6 | 7 | 8 | 13 | 30 | 34 | 23 | 14 |
| 1897 | 14 | 7 | 9 | 11 | 8 | 9 | 10 | 25 | 27 | 22 | 18 | 13 |
| Average | 8.1 | 5.6 | 6.5 | 8.1 | 8.1 | 8.1 | 8.8 | 20.0 | 26.7 | 27.8 | 17.7 | 14.3 |
| Ratio of 100 | 5.1 | 3.5 | 4.1 | 5.1 | 5.1 | 5.1 | 5.5 | 12.5 | 16.7 | 17.4 | 11.1 | 8.9 |

MEAN MONTHLY TEMPERATURE.

From "Monthly Weather Review," U. S. Weather Bureau.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1888 | 20 | 28 | 32 | 42 | 52 | 67 | 68 | 69 | 59 | 47 | 43 | 34 |
| 1889 | 36 | 26 | 38 | 48 | 60 | 69 | 69 | 67 | 63 | 48 | 45 | 38 |
| 1890 | 32 | 33 | 35 | 46 | 57 | 64 | 71 | 70 | 63 | 51 | 42 | 26 |
| 1891 | 31 | 32 | 34 | 48 | 56 | 65 | 69 | 70 | 67 | 52 | 41 | 40 |
| 1892 | 28 | 28 | 33 | 48 | 56 | 70 | 73 | 70 | 62 | 53 | 41 | 30 |
| 1893 | 21 | 27 | 34 | 44 | 56 | 65 | 71 | 70 | 60 | 55 | 42 | 30 |
| 1894 | 30 | 27 | 42 | 47 | 58 | 69 | 74 | 68 | 65 | 54 | 38 | 32 |
| 1895 | 29 | 25 | 35 | 46 | 60 | 67 | 69 | 71 | 66 | 50 | 45 | 36 |
| 1896 | 25 | 29 | 32 | 47 | 60 | 66 | 72 | 71 | 62 | 50 | 46 | 30 |
| 1897 | 28 | 31 | 37 | 49 | 58 | 62 | 72 | 70 | 63 | 54 | 41 | 34 |
| Average | 28 | 29 | 35 | 46 | 57 | 66 | 71 | 70 | 63 | 51 | 42 | 33 |

NEW YORK CITY.

MONTHLY TYPHOID DEATHS.

From Reports, State Board of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1887 | 28 | 13 | 21 | 11 | 11 | 16 | 33 | 51 | 53 | 38 | 26 | 22 |
| 1888 | 12 | 14 | 13 | 11 | 23 | 11 | 35 | 42 | 82 | 52 | 37 | 33 |
| 1889 | 27 | 15 | 21 | 18 | 15 | 19 | 31 | 71 | 57 | 57 | 40 | 21 |
| 1890 | 20 | 28 | 13 | 12 | 11 | 11 | 31 | 49 | 64 | 49 | 34 | 29 |
| 1891 | 14 | 11 | 17 | 13 | 20 | 23 | 28 | 57 | 65 | 56 | 51 | 29 |
| 1892 | 15 | 25 | 17 | 19 | 23 | 23 | 52 | 53 | 57 | 55 | 31 | 30 |
| 1893 | 22 | 19 | 29 | 25 | 29 | 23 | 21 | 35 | 42 | 70 | 41 | 26 |
| 1894 | 22 | 11 | 17 | 18 | 11 | 14 | 28 | 42 | 57 | 46 | 32 | 28 |
| 1895 | 17 | 16 | 8 | 14 | 13 | 23 | 27 | 37 | 46 | 48 | 37 | 36 |
| 1896 | 20 | 17 | 11 | 12 | 10 | 13 | 25 | 42 | 38 | 39 | 34 | 36 |
| Average | 19.7 | 16.9 | 16.7 | 15.3 | 16.6 | 17.6 | 31.1 | 47.9 | 56.1 | 51.0 | 36.3 | 29.0 |
| Ratio of 100 | 5.6 | 4.8 | 4.8 | 4.2 | 4.8 | 5.1 | 8.7 | 13.5 | 15.8 | 14.4 | 10.1 | 8.2 |

MONTHLY TEMPERATURE.

From "Monthly Weather Review," U. S. Weather Bureau.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1888 | 26 | 32 | 32 | 48 | 58 | 71 | 70 | 72 | 63 | 49 | 45 | 34 |
| 1889 | 38 | 28 | 41 | 52 | 62 | 70 | 73 | 71 | 66 | 52 | 47 | 41 |
| 1890 | 40 | 40 | 37 | 51 | 61 | 70 | 73 | 72 | 67 | 55 | 46 | 31 |
| 1891 | 35 | 37 | 38 | 52 | 60 | 70 | 71 | 74 | 70 | 54 | 44 | 42 |
| 1892 | 30 | 33 | 35 | 50 | 59 | 72 | 75 | 74 | 66 | 55 | 43 | 31 |
| 1893 | 23 | 30 | 36 | 48 | 59 | 69 | 75 | 74 | 64 | 58 | 44 | 35 |
| 1894 | 35 | 30 | 44 | 50 | 61 | 71 | 76 | 73 | 70 | 57 | 42 | 37 |
| 1895 | 30 | 25 | 36 | 48 | 59 | 70 | 71 | 74 | 70 | 51 | 46 | 37 |
| 1896 | 28 | 30 | 32 | 50 | 64 | 66 | 73 | 73 | 65 | 52 | 48 | 32 |
| 1897 | 29 | 33 | 39 | 49 | 59 | 65 | 73 | 71 | 65 | 56 | 44 | 36 |
| Average | 31 | 32 | 37 | 50 | 60 | 69 | 73 | 73 | 67 | 54 | 45 | 36 |

MASSACHUSETTS.

AVERAGE WEEKLY TYPHOID DEATHS FOR EACH MONTH.

From Reports, State Board of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|-----|
| 1886 | 6 | 5 | 4 | 5 | 3 | 3 | 4 | 10 | 15 | 16 | 11 | 10 |
| 1887 | 4 | 8 | 8 | 7 | 6 | 7 | 5 | 14 | 22 | 16 | 12 | 7 |
| 1888 | 6 | 5 | 6 | 7 | 5 | 6 | 5 | 10 | 16 | 26 | 11 | 8 |
| 1889 | 6 | 8 | 7 | 5 | 6 | 6 | 7 | 15 | 18 | 16 | 13 | 8 |
| 1890 | 6 | 7 | 5 | 4 | 5 | 5 | 4 | 9 | 16 | 14 | 18 | 15 |
| 1891 | 15 | 11 | 7 | 7 | 4 | 2 | 4 | 6 | 14 | 15 | 11 | 9 |
| 1892 | 6 | 5 | 7 | 4 | 5 | 5 | 6 | 9 | 11 | 37 | 11 | 12 |
| 1893 | 9 | 8 | 5 | 6 | 5 | 5 | 4 | 9 | 13 | 17 | 11 | 10 |
| 1894 | 5 | 7 | 4 | 5 | 6 | 2 | 4 | 7 | 16 | 15 | 15 | 9 |
| 1895 | 4 | 2 | 5 | 6 | 5 | 5 | 5 | 12 | 16 | 12 | 10 | 11 |
| Average | 6.7 | 6.6 | 5.8 | 5.6 | 5.0 | 4.6 | 4.8 | 10.1 | 15.7 | 18.4 | 12.3 | 9.9 |
| Ratio of 100 | 6.4 | 6.3 | 5.5 | 5.3 | 4.7 | 4.4 | 4.5 | 9.6 | 13.9 | 17.4 | 11.7 | 9.4 |

NEW YORK STATE.

MONTHLY TYPHOID DEATHS.

From Reports, State Board of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|-----|
| 1887 | 72 | 57 | 72 | 56 | 37 | 54 | 102 | 194 | 248 | 182 | 149 | 104 |
| 1888 | 64 | 84 | 81 | 45 | 59 | 45 | 73 | 174 | 279 | 288 | 153 | 138 |
| 1889 | 89 | 71 | 69 | 78 | 63 | 45 | 117 | 224 | 247 | 261 | 169 | 117 |
| 1890 | 117 | 94 | 72 | 73 | 72 | 69 | 101 | 167 | 234 | 240 | 216 | 157 |
| 1891 | 138 | 127 | 121 | 103 | 88 | 90 | 97 | 171 | 287 | 290 | 241 | 183 |
| 1892 | 116 | 98 | 96 | 77 | 71 | 75 | 131 | 182 | 282 | 205 | 184 | 147 |
| 1893 | 120 | 101 | 115 | 111 | 93 | 83 | 87 | 157 | 227 | 253 | 180 | 158 |
| 1894 | 105 | 86 | 131 | 94 | 85 | 72 | 93 | 183 | 229 | 234 | 189 | 139 |
| 1895 | 108 | 99 | 99 | 115 | 92 | 81 | 108 | 156 | 220 | 265 | 204 | 169 |
| 1896 | 158 | 121 | 103 | 87 | 59 | 66 | 103 | 171 | 221 | 195 | 132 | 126 |
| Average | 109 | 94 | 96 | 84 | 72 | 68 | 101 | 178 | 247 | 241 | 182 | 144 |
| Ratio of 100 | 6.7 | 5.8 | 5.9 | 5.2 | 4.5 | 4.2 | 6.3 | 11.0 | 15.3 | 14.9 | 11.3 | 8.9 |

ST. PAUL.

MONTHLY TYPHOID DEATHS.

From Reports, Local Board of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|-----|
| 1888 | 7 | 8 | 4 | 5 | 6 | 4 | 6 | 14 | 27 | 29 | 22 | 10 |
| 1890 | 7 | 4 | 2 | 5 | 0 | 2 | 2 | 17 | 11 | 6 | 6 | 3 |
| 1891 | 3 | 6 | 4 | 1 | 2 | 3 | 2 | 6 | 12 | 10 | 7 | 5 |
| 1892 | 2 | 1 | 6 | 1 | 0 | 0 | 2 | 1 | 4 | 12 | 7 | 11 |
| 1893 | 3 | 2 | 1 | 0 | 2 | 3 | 1 | 11 | 8 | 9 | 5 | 6 |
| 1894 | 0 | 1 | 1 | 1 | 0 | 2 | 2 | 4 | 6 | 5 | 6 | 4 |
| 1895 | 3 | 5 | 3 | 1 | 1 | 3 | 4 | 5 | 2 | 8 | 1 | 2 |
| 1896 | 7 | 6 | 3 | 3 | 1 | 1 | 0 | 5 | 0 | 4 | 5 | 2 |
| 1897 | 0 | 2 | 2 | 2 | 1 | 1 | 0 | 1 | 3 | 3 | 6 | 1 |
| Average | 3.6 | 3.9 | 2.9 | 2.1 | 1.4 | 2.1 | 2.1 | 7.1 | 8.1 | 8.4 | 7.2 | 4.9 |
| Ratio of 100 | 6.6 | 7.2 | 5.4 | 3.9 | 2.7 | 3.9 | 3.9 | 13.2 | 15.1 | 15.7 | 13.4 | 9.1 |

MEAN MONTHLY TEMPERATURE.

From "Monthly Weather Review," U. S. Weather Bureau.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1888 | —1 | 12 | 18 | 40 | 50 | 67 | 72 | 66 | 55 | 43 | 33 | 24 |
| 1889 | 20 | 10 | 37 | 48 | 56 | 64 | 71 | 70 | 59 | 45 | 29 | 29 |
| 1890 | 10 | 18 | 22 | 48 | 52 | 70 | 72 | 65 | 58 | 46 | 36 | 24 |
| 1891 | 21 | 11 | 23 | 48 | 58 | 65 | 66 | 67 | 66 | 48 | 26 | 27 |
| 1892 | 10 | 21 | 28 | 42 | 51 | 65 | 71 | 69 | 63 | 51 | 28 | 15 |
| 1893 | 3 | 9 | 23 | 39 | 54 | 71 | 73 | 69 | 62 | 49 | 30 | 12 |
| 1894 | 10 | 14 | 35 | 49 | 58 | 72 | 76 | 72 | 64 | 49 | 27 | 27 |
| 1895 | 6 | 11 | 28 | 52 | 59 | 67 | 70 | 70 | 65 | 44 | 31 | 21 |
| 1896 | 16 | 21 | 25 | 47 | 63 | 68 | 71 | 70 | 56 | 45 | 22 | 23 |
| 1897 | 9 | 19 | 24 | 46 | 57 | 64 | 74 | 66 | 68 | 53 | 29 | 15 |
| Average | 10 | 15 | 27 | 46 | 56 | 67 | 72 | 68 | 62 | 47 | 29 | 22 |

DENVER.

MONTHLY TYPHOID DEATHS.

From Reports, Local Department of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|-----|
| 1888 | 8 | 1 | 3 | 0 | 2 | 5 | 14 | 22 | 24 | 31 | 21 | 3 |
| 1889 | 4 | 0 | 1 | 1 | 4 | 1 | 14 | 23 | 51 | 55 | 22 | 12 |
| 1890 | 7 | 5 | 2 | 1 | 9 | 7 | 17 | 31 | 56 | 72 | 50 | 30 |
| 1891 | 13 | 9 | 4 | 3 | 2 | 3 | 6 | 11 | 15 | 17 | 9 | 7 |
| 1892 | 2 | 1 | 2 | 3 | 2 | 6 | 2 | 12 | 9 | 9 | 15 | 1 |
| 1893 | 4 | 4 | 0 | 5 | 8 | 5 | 8 | 4 | 5 | 10 | 15 | 3 |
| 1894 | 4 | 2 | 1 | 1 | 3 | 6 | 3 | 8 | 8 | 7 | 48 | 8 |
| 1895 | 5 | 1 | 2 | 1 | 2 | 2 | 2 | 5 | 8 | 6 | 8 | 2 |
| 1896 | 5 | 0 | 2 | 1 | 4 | 0 | 6 | 13 | 28 | 17 | 12 | 3 |
| Average | 5.8 | 2.6 | 1.9 | 1.8 | 4.0 | 3.9 | 8.0 | 15.4 | 22.7 | 24.9 | 22.2 | 7.7 |
| Ratio of 100 | 4.8 | 2.1 | 1.6 | 1.5 | 3.3 | 3.2 | 6.7 | 11.9 | 18.9 | 20.7 | 18.5 | 6.4 |

MEAN MONTHLY TEMPERATURE.

From "Monthly Weather Review," U. S. Weather Bureau.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1888 | 27 | 39 | 33 | 53 | 53 | 68 | 71 | 65 | 61 | 48 | 34 | 34 |
| 1889 | 27 | 30 | 43 | 51 | 55 | 64 | 72 | 73 | 60 | 52 | 32 | 40 |
| 1890 | 28 | 34 | 41 | 48 | 58 | 68 | 72 | 69 | 62 | 49 | 40 | 39 |
| 1891 | 25 | 27 | 32 | 48 | 56 | 63 | 70 | 69 | 64 | 52 | 38 | 31 |
| 1892 | 26 | 33 | 36 | 46 | 51 | 65 | 72 | 71 | 66 | 50 | 43 | 27 |
| 1893 | 38 | 31 | 38 | 45 | 54 | 69 | 73 | 70 | 63 | 51 | 39 | 38 |
| 1894 | 31 | 25 | 40 | 50 | 59 | 66 | 72 | 71 | 63 | 54 | 45 | 32 |
| 1895 | 28 | 27 | 37 | 50 | 56 | 62 | 67 | 70 | 66 | 51 | 38 | 34 |
| 1896 | 37 | 38 | 37 | 50 | 59 | 68 | 72 | 72 | 61 | 50 | 36 | 39 |
| 1897 | 27 | 31 | 36 | 47 | 61 | 65 | 70 | 70 | 66 | 51 | 41 | 28 |
| Average | 29 | 31 | 37 | 49 | 56 | 66 | 71 | 70 | 63 | 51 | 39 | 34 |

MONTREAL.

MONTHLY TYPHOID DEATHS.

From Reports, Local Department of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|-----|
| 1888 | 5 | 2 | 4 | 2 | 4 | 4 | 4 | 20 | 24 | 14 | 6 | 5 |
| 1889 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 15 | 19 | 8 | 6 | 6 |
| 1891 | 0 | 0 | 8 | 1 | 2 | 2 | 4 | 7 | 13 | 10 | 8 | 7 |
| 1892 | 4 | 6 | 3 | 0 | 1 | 2 | 4 | 6 | 8 | 12 | 15 | 4 |
| 1893 | 6 | 3 | 2 | 4 | 4 | 3 | 5 | 2 | 6 | 8 | 2 | 5 |
| 1894 | 6 | 3 | 4 | 5 | 3 | 0 | 1 | 6 | 6 | 1 | 6 | 1 |
| 1895 | 1 | 2 | 1 | 2 | 5 | 2 | 4 | 3 | 10 | 6 | 5 | 3 |
| 1896 | 3 | 3 | 2 | 2 | 3 | 1 | 7 | 4 | 4 | 9 | 4 | 4 |
| Average | 3.5 | 2.7 | 3.2 | 2.4 | 3.0 | 2.0 | 4.0 | 7.9 | 11.2 | 8.5 | 6.5 | 4.4 |
| Ratio of 100 | 5.9 | 4.6 | 5.5 | 4.0 | 5.1 | 3.4 | 6.7 | 13.3 | 18.9 | 14.3 | 10.9 | 7.4 |

MEAN MONTHLY TEMPERATURE.

From Reports, Local Department of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1888 | 4 | 12 | 23 | 37 | 54 | 66 | 68 | 64 | 55 | 40 | 33 | 23 |
| 1891 | 15 | 19 | 27 | 40 | 52 | 64 | 69 | 65 | 58 | 46 | 32 | 7 |
| 1892 | 15 | 17 | 26 | 42 | 52 | 65 | 66 | 67 | 62 | 45 | 35 | 30 |
| 1893 | 15 | 18 | 23 | 41 | 53 | 66 | 70 | 66 | 57 | 46 | 33 | 19 |
| 1894 | 13 | 13 | 32 | 45 | 56 | 66 | 69 | 63 | 60 | 49 | 30 | 23 |
| 1895 | 15 | 14 | 22 | 41 | 58 | 70 | 67 | 66 | 60 | 41 | 34 | 22 |
| 1896 | 12 | 15 | 20 | 41 | 58 | 65 | 69 | 67 | 57 | 43 | 35 | 18 |
| Average | 13 | 15 | 25 | 41 | 55 | 66 | 68 | 65 | 58 | 44 | 33 | 20 |

BALTIMORE.

MONTHLY TYPHOID DEATHS.

From Reports, Local Department of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|------|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1888 | 7 | 8 | 6 | 6 | 5 | 10 | 4 | 26 | 34 | 21 | 17 | 17 |
| 1889 | 15 | 7 | 14 | 4 | 12 | 16 | 8 | 30 | 26 | 14 | 19 | 26 |
| 1890 | 10 | 12 | 15 | 19 | 13 | 13 | 29 | 36 | 30 | 34 | 25 | 11 |
| 1891 | 15 | 8 | 3 | 5 | 9 | 6 | 9 | 14 | 22 | 29 | 17 | 13 |
| 1892 | 13 | 9 | 8 | 9 | 11 | 8 | 16 | 30 | 26 | 29 | 21 | 13 |
| 1893 | 20 | 5 | 11 | 10 | 4 | 13 | 23 | 33 | 32 | 27 | 34 | 12 |
| 1894 | 12 | 8 | 6 | 14 | 14 | 8 | 18 | 39 | 28 | 31 | 21 | 23 |
| 1895 | 11 | 11 | 6 | 9 | 7 | 3 | 24 | 12 | 27 | 31 | 19 | 13 |
| 1896 | 7 | 11 | 4 | 11 | 11 | 13 | 19 | 23 | 29 | 28 | 22 | 10 |
| 1897 | 7 | 8 | 6 | 6 | 6 | 8 | 13 | 36 | 36 | 27 | 19 | 17 |
| Average | 12.7 | 8.9 | 7.9 | 9.3 | 9.2 | 9.8 | 16.3 | 27.9 | 29.0 | 27.1 | 21.4 | 15.5 |
| Ratio of 100 | 6.6 | 4.6 | 4.1 | 4.8 | 4.8 | 5.1 | 8.4 | 14.4 | 15.0 | 14.0 | 11.1 | 8.0 |

MEAN MONTHLY TEMPERATURE.

From "Monthly Weather Review," U. S. Weather Bureau.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1888 | 29 | 35 | 37 | 53 | 63 | 73 | 74 | 75 | 64 | 51 | 47 | 36 |
| 1889 | 39 | 31 | 43 | 55 | 66 | 71 | 77 | 74 | 66 | 54 | 48 | 46 |
| 1890 | 44 | 43 | 42 | 54 | 64 | 75 | 75 | 74 | 68 | 57 | 48 | 35 |
| 1891 | 38 | 41 | 39 | 56 | 62 | 71 | 72 | 74 | 71 | 55 | 44 | 44 |
| 1892 | 32 | 37 | 37 | 52 | 63 | 76 | 76 | 76 | 66 | 56 | 44 | 33 |
| 1893 | 25 | 34 | 40 | 53 | 61 | 72 | 77 | 75 | 67 | 57 | 44 | 39 |
| 1894 | 37 | 34 | 48 | 52 | 65 | 73 | 78 | 73 | 71 | 57 | 43 | 38 |
| 1895 | 31 | 26 | 41 | 53 | 62 | 74 | 73 | 77 | 72 | 53 | 47 | 39 |
| 1896 | 34 | 36 | 38 | 57 | 69 | 71 | 78 | 76 | 68 | 55 | 51 | 36 |
| 1897 | 32 | 37 | 45 | 53 | 63 | 70 | 77 | 74 | 69 | 58 | 46 | 39 |
| Average | 34 | 35 | 41 | 54 | 64 | 73 | 76 | 75 | 68 | 55 | 46 | 38 |

LONDON.

WEEKLY TYPHOID DEATHS AND AVERAGE MEAN TEMPERATURE.

From the Weekly Returns of the Registrar-General.

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. |
|---------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Deaths . . . | 13 | 14 | 13 | 11 | 12 | 7 | 10 | 9 | 9 | 9 | 9 | 7 | 8 |
| Temperature . | 38 | 38 | 38 | 39 | 40 | 39 | 40 | 40 | 41 | 41 | 42 | 42 | 45 |
| | 14. | 15. | 16. | 17. | 18. | 19. | 20. | 21. | 22. | 23. | 24. | 25. | 26. |
| Deaths . . . | 9 | 6 | 8 | 7 | 8 | 7 | 9 | 8 | 8 | 7 | 9 | 9 | 9 |
| Temperature . | 46 | 46 | 48 | 48 | 50 | 52 | 54 | 56 | 57 | 58 | 59 | 60 | 61 |
| | 27. | 28. | 29. | 30. | 31. | 32. | 33. | 34. | 35. | 36. | 37. | 38. | 39. |
| Deaths . . . | 8 | 10 | 7 | 9 | 10 | 9 | 13 | 12 | 19 | 15 | 16 | 17 | 17 |
| Temperature . | 62 | 63 | 63 | 62 | 62 | 63 | 62 | 61 | 60 | 59 | 58 | 56 | 55 |
| | 40. | 41. | 42. | 43. | 44. | 45. | 46. | 47. | 48. | 49. | 50. | 51. | 52. |
| Deaths . . . | 17 | 19 | 19 | 18 | 20 | 19 | 19 | 20 | 17 | 16 | 19 | 15 | 16 |
| Temperature . | 53 | 51 | 49 | 47 | 47 | 45 | 42 | 41 | 41 | 41 | 40 | 39 | 38 |

Weekly typhoid rate is average for ten years, 1888-1897. Temperature is average for years, 1840-1890.

AVERAGE WEEKLY TYPHOID DEATHS FOR EACH MONTH.

| | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Deaths | 13.0 | 9.0 | 8.0 | 7.0 | 8.0 | 8.0 | 8.0 | 16.0 | 16.0 | 18.0 | 19.0 | 16.0 |
| Ratio of 100 . . . | 8.9 | 6.2 | 5.5 | 4.8 | 5.5 | 5.5 | 5.5 | 11.0 | 11.0 | 12.3 | 13.0 | 11.0 |
| Temperature . . . | 38.0 | 40.0 | 42.0 | 47.0 | 53.0 | 59.0 | 62.0 | 62.0 | 57.0 | 50.0 | 43.0 | 40.0 |

LEIPSIC.

MONTHLY TYPHOID DEATHS.

From "Veröffentlichungen des Kaiserlichen Gesundheitsamtes."

| | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| 1888 | 1 | 2 | 1 | 1 | 1 | 3 | 2 | 1 | 1 | 0 | 4 | 2 |
| 1889 | 2 | 2 | 2 | 2 | 1 | 0 | 4 | 6 | 6 | 6 | 3 | 2 |
| 1890 | 6 | 1 | 1 | 0 | 1 | 5 | 2 | 7 | 6 | 4 | 3 | 6 |
| 1891 | 5 | 5 | 4 | 6 | 5 | 1 | 6 | 5 | 6 | 4 | 3 | 4 |
| 1892 | 0 | 3 | 1 | 0 | 1 | 1 | 4 | 3 | 4 | 7 | 3 | 2 |
| 1893 | 2 | 2 | 0 | 0 | 0 | 3 | 4 | 1 | 6 | 2 | 1 | 6 |
| 1894 | 1 | 2 | 2 | 1 | 5 | 5 | 4 | 3 | 2 | 4 | 5 | 4 |
| 1895 | 0 | 3 | 1 | 1 | 2 | 2 | 0 | 3 | 8 | 5 | 6 | 2 |
| 1896 | 2 | 3 | 2 | 5 | 1 | 1 | 1 | 3 | 2 | 2 | 3 | 7 |
| 1897 | 3 | 5 | 3 | 1 | 2 | 1 | 2 | 5 | 8 | 3 | 4 | 0 |
| Average | 2.2 | 2.8 | 1.7 | 1.7 | 1.9 | 2.2 | 2.9 | 3.7 | 4.9 | 3.7 | 3.5 | 3.5 |
| Ratio of 100 | 6.3 | 8.1 | 4.9 | 4.9 | 5.5 | 6.3 | 8.4 | 10.7 | 14.1 | 10.7 | 10.1 | 10.1 |

MEAN MONTHLY TEMPERATURE. 1864-1890.

From "Amtliche Publication des Königl. sächsischen meteorologischen Institutes. Das Klima des Königreiches Sachsen." Heft III, 1895.

| | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|------------|----|----|----|----|----|----|----|----|----|----|----|----|
| Centigrade | -1 | 0 | 3 | 8 | 13 | 17 | 18 | 17 | 14 | 8 | 3 | 0 |
| Fahrenheit | 30 | 32 | 37 | 46 | 55 | 63 | 64 | 63 | 57 | 46 | 37 | 32 |

BERLIN.

MONTHLY TYPHOID DEATHS.

From "Veröffentlichungen des Kaiserlichen Gesundheitsamtes."

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|------|-----|------|-----|-----|-----|------|------|------|------|------|------|
| 1888 | 38 | 19 | 10 | 11 | 8 | 10 | 18 | 22 | 13 | 15 | 11 | 13 |
| 1889 | 11 | 21 | 58 | 23 | 14 | 11 | 28 | 20 | 23 | 18 | 36 | 27 |
| 1890 | 14 | 15 | 11 | 9 | 10 | 8 | 10 | 16 | 18 | 18 | 9 | 5 |
| 1891 | 9 | 7 | 16 | 7 | 9 | 9 | 7 | 20 | 19 | 31 | 20 | 12 |
| 1892 | 12 | 6 | 15 | 7 | 10 | 10 | 7 | 9 | 23 | 15 | 10 | 13 |
| 1893 | 7 | 6 | 11 | 8 | 13 | 8 | 7 | 19 | 42 | 16 | 18 | 5 |
| 1894 | 7 | 9 | 8 | 7 | 7 | 5 | 7 | 5 | 10 | 10 | 5 | 12 |
| 1895 | 6 | 7 | 8 | 2 | 4 | 14 | 8 | 16 | 22 | 17 | 8 | 14 |
| 1896 | 9 | 6 | 6 | 11 | 8 | 6 | 11 | 14 | 17 | 11 | 4 | 5 |
| 1897 | 3 | 1 | 8 | 8 | 5 | 4 | 4 | 20 | 11 | 10 | 7 | 9 |
| Average | 11.6 | 9.7 | 15.1 | 9.3 | 8.8 | 8.5 | 10.7 | 16.1 | 19.8 | 16.1 | 12.8 | 11.5 |
| Ratio of 100 | 8.0 | 6.7 | 10.0 | 6.0 | 6.0 | 5.3 | 7.3 | 10.7 | 13.3 | 10.7 | 8.7 | 7.3 |

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MEAN MONTHLY TEMPERATURE.

From "Ergebnisse der meteorologischen Beobachtungen von dem Königlich. Preussischen meteorologischen Institut."

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|------------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1888 | -1 | -2 | 0 | 7 | 14 | 17 | 17 | 17 | 15 | 8 | 4 | 2 |
| 1889 | -2 | -1 | 1 | 9 | 19 | 22 | 18 | 17 | 13 | 9 | 4 | 0 |
| 1890 | 3 | -1 | 6 | 9 | 16 | 16 | 18 | 19 | 15 | 9 | 4 | -4 |
| 1891 | -3 | 1 | 4 | 6 | 15 | 16 | 18 | 17 | 16 | 11 | 4 | 3 |
| 1892 | -1 | 1 | 2 | 8 | 13 | 17 | 18 | 20 | 16 | 9 | 2 | -1 |
| 1893 | -7 | 2 | 5 | 9 | 13 | 17 | 19 | 18 | 13 | 11 | 3 | 1 |
| 1894 | -1 | 3 | 6 | 11 | 13 | 16 | 20 | 17 | 12 | 9 | 5 | 1 |
| Average | -2 | 0 | 3 | 8 | 15 | 17 | 18 | 18 | 14 | 9 | 4 | 0 |
| Fahrenheit | 28 | 32 | 37 | 46 | 59 | 63 | 64 | 64 | 57 | 48 | 39 | 32 |

EMPIRE OF JAPAN.

MONTHLY TYPHOID DEATHS.

From Annual Reports of the Central Sanitary Bureau of Japan.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|-------------------------|------------|------------|------------|------------|------------|------------|------------|-------------|--------------|--------------|-------------|------------|
| 1890 | 568 | 386 | 380 | 402 | 540 | 527 | 603 | 838 | 1159 | 1309 | 977 | 775 |
| 1891 | 556 | 285 | 264 | 392 | 724 | 1038 | 1028 | 940 | 1255 | 1286 | 1009 | 837 |
| 1892 | 541 | 382 | 366 | 405 | 468 | 628 | 734 | 938 | 1165 | 1252 | 921 | 729 |
| 1893 | 508 | 361 | 368 | 340 | 450 | 520 | 646 | 827 | 1190 | 1262 | 1016 | 695 |
| 1894 | 515 | 319 | 226 | 256 | 338 | 515 | 681 | 1068 | 1298 | 1141 | 995 | 702 |
| Average Ratio of 100 | 538 6.3 | 347 4.1 | 321 3.8 | 359 4.2 | 504 5.9 | 646 7.5 | 738 8.6 | 922 10.8 | 1203 14.1 | 1250 14.6 | 984 11.5 | 748 8.8 |

MEAN MONTHLY TEMPERATURE. (10 stations.) (3-6 years.)

From "The Climate of Japan," Central Meteorological Observatory, Tokio, 1893.

| Stations. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|-------------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|---------|---------|
| Kumamoto | 3 | 7 | 10 | 16 | 19 | 22 | 26 | 27 | 25 | 18 | 12 | 8 |
| Matsuyama | 4 | 6 | 8 | 13 | 17 | 21 | 25 | 26 | 23 | 17 | 12 | 9 |
| Hiroshima . | 3 | 5 | 8 | 13 | 19 | 22 | 25 | 27 | 23 | 17 | 11 | 7 |
| Ozaka . . | 4 | 5 | 9 | 14 | 18 | 22 | 26 | 27 | 24 | 17 | 12 | 7 |
| Wakayama | 5 | 5 | 9 | 14 | 18 | 22 | 26 | 27 | 23 | 17 | 12 | 8 |
| Nagano . | -2 | 0 | 4 | 11 | 14 | 19 | 23 | 24 | 20 | 12 | 7 | 4 |
| Tokio . . | 3 | 4 | 7 | 13 | 16 | 21 | 24 | 26 | 22 | 16 | 11 | 6 |
| Hakodate . | -4 | -2 | 3 | 7 | 11 | 14 | 18 | 21 | 18 | 11 | 5 | 1 |
| Sapporo . | -7 | -5 | 0 | 5 | 11 | 15 | 19 | 21 | 17 | 9 | 3 | -1 |
| Nemuro . | -6 | -5 | -1 | 4 | 7 | 10 | 15 | 18 | 16 | 10 | 4 | 0 |
| Average . Fahrenheit | 0 32 | 2 36 | 6 43 | 11 52 | 15 59 | 19 66 | 23 74 | 24 75 | 21 70 | 14 58 | 9 48 | 5 41 |

SAN FRANCISCO.

MONTHLY TYPHOID DEATHS.

From Reports, Local Department of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|------|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1888 | | | | | | | 12 | 10 | 18 | 13 | 15 | 12 |
| 1889 | 6 | 10 | 8 | 13 | 12 | 9 | | | | | | |
| 1890 | 17 | 6 | 7 | 6 | 4 | 17 | 17 | 13 | 11 | 21 | 14 | 10 |
| 1891 | 13 | 6 | 10 | 5 | 9 | 8 | 18 | 16 | 7 | 8 | 11 | 12 |
| 1892 | 8 | 6 | 8 | 4 | 4 | 1 | 13 | 14 | 5 | 13 | 11 | 7 |
| 1893 | 4 | 5 | 3 | 4 | 3 | 12 | 10 | 11 | 10 | 9 | 16 | 10 |
| 1894 | 11 | 7 | 5 | 5 | 9 | 6 | 8 | 13 | 12 | 9 | 10 | 20 |
| 1895 | 14 | 11 | 4 | 6 | 5 | 11 | 16 | 5 | 12 | 8 | 7 | 9 |
| 1896 | 10 | 6 | 6 | 5 | 7 | 10 | 0 | 8 | 7 | 10 | 7 | 9 |
| 1897 | 13 | 2 | 7 | 5 | 3 | 4 | 3 | 4 | — | 5 | 4 | 4 |
| Average | 10.7 | 6.7 | 6.4 | 5.9 | 6.2 | 8.7 | 10.8 | 10.4 | 10.2 | 10.7 | 10.6 | 10.3 |
| Ratio of 100 | 9.9 | 6.1 | 6.0 | 5.5 | 5.8 | 8.1 | 10.0 | 9.7 | 9.4 | 9.9 | 9.8 | 9.6 |

MEAN MONTHLY TEMPERATURE.

From "Monthly Weather Review," U. S. Weather Bureau.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1888 | 46 | 53 | 52 | 56 | 55 | 61 | 59 | 58 | 59 | 59 | 55 | 52 |
| 1889 | 50 | 54 | 57 | 59 | 59 | 60 | 59 | 60 | 65 | 62 | 59 | 51 |
| 1890 | 46 | 49 | 54 | 55 | 60 | 59 | 60 | 61 | 60 | 62 | 59 | 50 |
| 1891 | 52 | 51 | 55 | 53 | 56 | 60 | 59 | 62 | 62 | 60 | 59 | 50 |
| 1892 | 52 | 52 | 54 | 53 | 58 | 57 | 58 | 59 | 60 | 60 | 57 | 51 |
| 1893 | 47 | 50 | 51 | 52 | 56 | 56 | 57 | 57 | 59 | 58 | 56 | 52 |
| 1894 | 48 | 48 | 51 | 55 | 55 | 56 | 56 | 59 | 63 | 60 | 59 | 50 |
| 1895 | 49 | 54 | 52 | 55 | 58 | 59 | 58 | 58 | 61 | 59 | 56 | 49 |
| 1896 | 52 | 55 | 54 | 52 | 56 | 57 | 59 | 59 | 60 | 59 | 53 | 53 |
| 1897 | 49 | 51 | 49 | 57 | 57 | 59 | 58 | 58 | 61 | 58 | 53 | 51 |
| Average | 49 | 52 | 53 | 55 | 56 | 58 | 58 | 59 | 61 | 60 | 57 | 51 |

CINCINNATI.

MONTHLY TYPHOID DEATHS.

From Reports, Local Department of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|------|------|------|------|-----|-----|------|------|------|------|------|------|
| 1888 | 41 | 34 | 16 | 11 | 6 | 7 | 6 | 12 | 17 | 16 | 22 | 15 |
| 1889 | 11 | 14 | 11 | 19 | 7 | 9 | 12 | 14 | 14 | 11 | 12 | 9 |
| 1890 | 18 | 11 | 17 | 9 | 14 | 14 | 23 | 24 | 20 | 23 | 23 | 9 |
| 1891 | 10 | 17 | 14 | 21 | 14 | 21 | 10 | 16 | 7 | 22 | 22 | 12 |
| 1892 | 17 | 10 | 8 | 4 | 4 | 7 | 6 | 10 | 12 | 9 | 11 | 23 |
| 1893 | 10 | 14 | 8 | 4 | 14 | 6 | 8 | 15 | 14 | 12 | 12 | 17 |
| 1894 | 18 | 11 | 15 | 10 | 10 | 8 | 12 | 6 | 10 | 21 | 11 | 37 |
| 1895 | 22 | 12 | 7 | 6 | 5 | 5 | 7 | 7 | 8 | 10 | 8 | 23 |
| 1896 | 34 | 22 | 15 | 11 | 11 | 5 | 6 | 14 | 9 | 11 | 11 | 15 |
| 1897 | 9 | 8 | 5 | 5 | 10 | 3 | 17 | 9 | 9 | 9 | 6 | 11 |
| Average | 19.0 | 15.3 | 12.6 | 10.0 | 9.5 | 8.5 | 10.7 | 12.7 | 12.0 | 14.4 | 13.8 | 17.1 |
| Ratio of 100 | 12.3 | 9.9 | 8.2 | 6.5 | 6.2 | 5.5 | 6.9 | 8.2 | 7.8 | 9.4 | 8.9 | 11.1 |

MEAN MONTHLY TEMPERATURE.

From "Monthly Weather Review," U. S. Weather Bureau.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1888 | 29 | 35 | 39 | 55 | 63 | 74 | 76 | 73 | 63 | 50 | 45 | 36 |
| 1889 | 37 | 30 | 46 | 54 | 63 | 70 | 75 | 72 | 66 | 52 | 43 | 48 |
| 1890 | 41 | 43 | 40 | 56 | 64 | 78 | 77 | 73 | 66 | 56 | 48 | 36 |
| 1891 | 36 | 40 | 38 | 56 | 60 | 74 | 71 | 72 | 70 | 55 | 43 | 42 |
| 1892 | 26 | 39 | 38 | 53 | 62 | 75 | 76 | 75 | 68 | 56 | 40 | 32 |
| 1893 | 21 | 34 | 42 | 54 | 61 | 73 | 79 | 75 | 70 | 56 | 42 | 36 |
| 1894 | 38 | 33 | 49 | 54 | 63 | 75 | 77 | 77 | 72 | 57 | 41 | 37 |
| 1895 | 27 | 24 | 41 | 55 | 64 | 76 | 75 | 77 | 73 | 51 | 44 | 37 |
| 1896 | 34 | 35 | 37 | 62 | 71 | 73 | 76 | 75 | 65 | 53 | 48 | 38 |
| 1897 | 29 | 36 | 46 | 52 | 59 | 72 | 78 | 74 | 71 | 63 | 46 | 36 |
| Average | 32 | 35 | 42 | 55 | 63 | 74 | 76 | 74 | 68 | 55 | 44 | 38 |

DISTRICT OF COLUMBIA.

MONTHLY TYPHOID DEATHS.

From Reports, Local Department of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|-----|-----|-----|-----|-----|------|------|------|------|------|------|------|
| 1887 | | | | | | | 18 | 32 | 22 | 20 | 18 | 15 |
| 1888 | 8 | 7 | 8 | 7 | 3 | 10 | 12 | 23 | 27 | 34 | 19 | 7 |
| 1889 | 14 | 7 | 9 | 5 | 6 | 7 | 23 | 18 | 29 | 15 | 18 | 29 |
| 1890 | 9 | 6 | 19 | 11 | 10 | 21 | 33 | 26 | 29 | 30 | 21 | 17 |
| 1891 | 12 | 6 | 12 | 9 | 5 | 8 | 6 | 22 | 21 | 36 | 26 | 12 |
| 1892 | 13 | 13 | 8 | 7 | 8 | 11 | 19 | 21 | 30 | 22 | 25 | 18 |
| 1893 | 6 | 7 | 6 | 11 | 11 | 10 | 21 | 24 | 28 | 23 | 23 | 21 |
| 1894 | 10 | 5 | 5 | 6 | 5 | 20 | 33 | 30 | 26 | 30 | 24 | 16 |
| 1895 | 3 | 8 | 1 | 1 | 1 | 1 | 12 | 27 | 56 | 55 | 24 | 20 |
| 1896 | 9 | 8 | 3 | 3 | 4 | 7 | 8 | 15 | 25 | 25 | 18 | 16 |
| 1897 | 13 | 4 | 4 | 4 | 6 | 9 | | | | | | |
| Average | 9.7 | 7.1 | 7.5 | 6.4 | 5.9 | 10.4 | 18.5 | 23.8 | 29.3 | 29.0 | 21.6 | 17.1 |
| Ratio of 100 | 5.2 | 3.8 | 4.1 | 3.5 | 3.2 | 5.6 | 10.0 | 12.9 | 15.8 | 15.7 | 11.7 | 9.2 |

MEAN MONTHLY TEMPERATURE.

From Reports, Local Department of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1887 | | | | | | | 80.5 | 73.2 | 65.0 | 55.4 | 44.9 | 37.2 |
| 1888 | 29.2 | 35.7 | 37.5 | 52.9 | 62.7 | 73.0 | 72.9 | 73.9 | 63.2 | 50.5 | 45.8 | 35.2 |
| 1889 | 36.8 | 29.4 | 42.3 | 53.2 | 63.8 | 69.8 | 74.2 | 70.6 | 65.6 | 52.5 | 46.2 | 45.6 |
| 1890 | 44.2 | 43.4 | 41.4 | 53.7 | 63.8 | 74.9 | 75.1 | 73.5 | 67.7 | 56.2 | 47.8 | 34.2 |
| 1891 | 37.3 | 41.5 | 38.5 | 55.4 | 61.3 | 71.4 | 72.0 | 74.5 | 79.2 | 54.4 | 43.9 | 43.1 |
| 1892 | 31.7 | 36.9 | 37.7 | 51.5 | 63.8 | 76.2 | 75.7 | 76.2 | 66.2 | 55.0 | 43.6 | 33.0 |
| 1893 | 24.0 | 34.9 | 41.0 | 54.0 | 61.6 | 72.0 | 77.0 | 74.7 | 66.0 | 56.4 | 43.6 | 38.4 |
| 1894 | 37.7 | 35.2 | 48.6 | 53.2 | 64.8 | 73.7 | 78.0 | 73.9 | 71.4 | 57.8 | 43.8 | 37.4 |
| 1895 | 31.6 | 26.2 | 41.8 | 53.8 | 62.6 | 74.6 | 72.7 | 77.3 | 72.4 | 52.1 | 46.4 | 38.7 |
| 1896 | 33.3 | 36.6 | 38.6 | 66.5 | 68.8 | 71.3 | 76.6 | 75.7 | 67.7 | 54.0 | 50.6 | 35.5 |
| 1897 | 30.9 | 36.5 | 46.0 | 53.0 | 62.5 | 69.7 | | | | | | |
| Average | 34 | 36 | 41 | 55 | 64 | 73 | 75 | 74 | 68 | 54 | 46 | 38 |

MOBILE.

MONTHLY TYPHOID DEATHS.

Obtained, in correspondence, by courtesy of Local Department of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|-----|-----|-----|-----|-----|------|------|------|------|------|-----|-----|
| 1889 | 0 | 0 | 2 | 2 | 0 | 2 | 2 | 3 | 1 | 1 | 1 | 2 |
| 1890 | 0 | 2 | 0 | 1 | 1 | 2 | 6 | 2 | 0 | 1 | 0 | 1 |
| 1891 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | 0 | 4 | 3 | 2 | 0 |
| 1892 | 0 | 1 | 0 | 0 | 1 | 1 | 4 | 3 | 1 | 2 | 0 | 1 |
| 1893 | 1 | 1 | 1 | 1 | 0 | 4 | 3 | 1 | 2 | 2 | 0 | 0 |
| 1894 | 1 | 2 | 0 | 0 | 1 | 2 | 4 | 1 | 1 | 1 | 1 | 1 |
| 1895 | 3 | 0 | 0 | 0 | 2 | 1 | 2 | 3 | 4 | 4 | 1 | 2 |
| 1896 | 1 | 0 | 0 | 0 | 2 | 1 | 5 | 1 | 0 | 2 | 3 | 1 |
| 1897 | 1 | 1 | 0 | 0 | 1 | 3 | 4 | 2 | 5 | 1 | 2 | 0 |
| 1898 | 1 | 0 | 2 | 1 | 1 | 2 | 6 | 4 | 2 | 2 | 1 | 1 |
| Average | .8 | .7 | .5 | .5 | 1.1 | 1.8 | 3.9 | 2.0 | 2.0 | 1.9 | 1.1 | .9 |
| Ratio of 100 | 4.6 | 4.1 | 2.9 | 2.9 | 6.4 | 10.4 | 22.6 | 11.6 | 11.6 | 11.0 | 6.4 | 5.2 |

MEAN MONTHLY TEMPERATURE.

From "Monthly Weather Review," U. S. Weather Bureau.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1889 | 51 | 51 | 59 | 68 | 70 | 77 | 81 | 79 | 77 | 66 | 56 | 61 |
| 1890 | 62 | 61 | 57 | 68 | 73 | 80 | 80 | 80 | 77 | 67 | 61 | 54 |
| 1891 | 49 | 59 | 59 | 66 | 72 | 80 | 80 | 80 | 77 | 65 | 57 | 53 |
| 1892 | 47 | 57 | 55 | 66 | 72 | 79 | 79 | 80 | 75 | 69 | 58 | 52 |
| 1893 | 46 | 58 | 57 | 69 | 74 | 79 | 82 | 81 | 78 | 66 | 58 | 55 |
| 1894 | 55 | 53 | 60 | 69 | 74 | 78 | 79 | 80 | 78 | 68 | 57 | 54 |
| 1895 | 49 | 43 | 58 | 66 | 72 | 79 | 81 | 81 | 81 | 65 | 58 | 50 |
| 1896 | 49 | 53 | 57 | 69 | 76 | 79 | 81 | 82 | 77 | 68 | 62 | 51 |
| 1897 | 48 | 55 | 66 | 66 | 71 | 81 | 82 | 80 | 78 | 71 | 60 | 54 |
| 1898 | 55 | 53 | 63 | 62 | 75 | 80 | 81 | 80 | 78 | 65 | 56 | 49 |
| Average | 51 | 54 | 59 | 67 | 73 | 79 | 81 | 80 | 78 | 67 | 58 | 53 |

OAKLAND.

MONTHLY TYPHOID DEATHS.

Obtained, in correspondence, by courtesy of Local Department of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|-----|-----|-----|-----|-----|-----|------|-----|------|------|-----|-----|
| 1889 | 1 | 1 | 4 | 2 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 1 |
| 1890 | 2 | 0 | 5 | 1 | 0 | 1 | 2 | 1 | 2 | 3 | 2 | 3 |
| 1891 | 0 | 0 | 0 | 2 | 2 | 1 | 3 | 4 | 6 | 2 | 3 | 3 |
| 1892 | 0 | 2 | 1 | 2 | 3 | 1 | 1 | 2 | 0 | 5 | 1 | 2 |
| 1893 | 0 | 2 | 0 | 0 | 1 | 4 | 22 | 4 | 7 | 2 | 3 | 1 |
| 1894 | 1 | 2 | 3 | 1 | 0 | 1 | 2 | 2 | 0 | 1 | 0 | 1 |
| 1895 | 2 | 3 | 0 | 3 | 2 | 0 | 3 | 1 | 2 | 0 | 1 | 1 |
| 1896 | 1 | 3 | 1 | 0 | 1 | 2 | 0 | 0 | 2 | 3 | 3 | 2 |
| 1897 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 2 | 1 | 1 | 1 |
| 1898 | 0 | 0 | 0 | 0 | 2 | 1 | 3 | 2 | 1 | 1 | 1 | 1 |
| Average | 0.8 | 1.4 | 1.4 | 1.1 | 1.4 | 1.1 | 3.7 | 1.7 | 2.3 | 2.1 | 1.8 | 1.6 |
| Ratio of 100 | 3.9 | 6.9 | 6.9 | 5.4 | 6.9 | 5.4 | 18.1 | 8.3 | 11.3 | 10.3 | 8.8 | 7.8 |

MEAN MONTHLY TEMPERATURE.

From "Monthly Weather Review," U. S. Weather Bureau.

| Year | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1889 | 48 | 50 | 57 | 59 | 59 | 61 | 60 | 61 | 63 | 61 | 57 | 50 |
| 1890 | 44 | 48 | 54 | 55 | 60 | 59 | 62 | 62 | 61 | 62 | 57 | 49 |
| 1891 | 51 | 49 | 53 | 53 | 55 | 60 | 61 | 63 | 62 | 59 | 57 | 49 |
| 1892 | 52 | 50 | 53 | 53 | 58 | 62 | 64 | 64 | 63 | 58 | 53 | 49 |
| 1893 | 49 | 51 | 54 | 56 | 58 | 62 | 62 | 61 | 62 | 58 | 54 | 51 |
| 1894 | 45 | 48 | 52 | 57 | 59 | 61 | 59 | 61 | 62 | 59 | 56 | 49 |
| 1895 | 47 | 52 | 51 | 56 | 59 | 60 | 63 | 59 | 62 | 56 | 54 | 47 |
| 1896 | 51 | 53 | 55 | 54 | 58 | 61 | 64 | 63 | — | 58 | 51 | 49 |
| 1897 | 46 | 49 | 49 | 59 | 61 | 64 | 63 | 61 | 63 | 58 | 51 | 47 |
| 1898 | 44 | 51 | 51 | 57 | 57 | 64 | 62 | 62 | 61 | 60 | 53 | 47 |
| Average | 48 | 50 | 53 | 56 | 58 | 61 | 62 | 62 | 62 | 59 | 54 | 49 |

DRESDEN.

MONTHLY TYPHOID DEATHS.

From "Veröffentlichungen des Kaiserlichen Gesundheitsamtes."

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|-----|-----|-----|------|-----|-----|-----|------|-----|-----|------|-----|
| 1888 | 4 | 2 | 2 | 1 | 1 | 0 | 0 | 6 | 4 | 1 | 2 | 3 |
| 1889 | 4 | 2 | 0 | 1 | 3 | 1 | 2 | 4 | 1 | 2 | 1 | 0 |
| 1890 | 1 | 3 | 4 | 0 | 1 | 1 | 1 | 2 | 1 | 3 | 3 | 2 |
| 1891 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 3 | 3 | 0 | 5 | 2 |
| 1892 | 0 | 0 | 4 | 1 | 0 | 1 | 2 | 1 | 1 | 3 | 1 | 2 |
| 1893 | 1 | 0 | 1 | 3 | 1 | 0 | 0 | 0 | 1 | 1 | 3 | 2 |
| 1894 | 0 | 0 | 1 | 8 | 3 | 2 | 1 | 3 | 5 | 1 | 2 | 0 |
| 1895 | 1 | 1 | 0 | 0 | 2 | 1 | 4 | 3 | 1 | 1 | 2 | 1 |
| 1896 | 0 | 0 | 0 | 4 | 2 | 2 | 1 | 1 | 0 | 1 | 1 | 3 |
| 1897 | 0 | 0 | 1 | 1 | 1 | 0 | 3 | 0 | 2 | 1 | 2 | 1 |
| Average | 1.4 | .9 | 1.6 | 2.0 | 1.6 | 1.0 | 1.6 | 2.3 | 1.9 | 1.4 | 2.2 | 1.6 |
| Ratio of 100 | 7.2 | 4.6 | 8.2 | 10.3 | 8.2 | 5.1 | 8.2 | 11.8 | 9.7 | 7.2 | 11.3 | 8.2 |

MEAN MONTHLY TEMPERATURE. AVERAGE 1864-1890.

From "Amtliche Publication des Königl. sächsischen meteorologischen Institutes. Das Klima des Königreiches Sachsen." Heft III, 1895.

| | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|------------|----|----|----|----|----|----|----|----|----|----|----|----|
| Centigrade | 0 | 1 | 3 | 8 | 13 | 16 | 18 | 17 | 14 | 9 | 4 | 0 |
| Fahrenheit | 32 | 34 | 37 | 46 | 55 | 61 | 64 | 63 | 57 | 48 | 39 | 32 |

MUNICH.

MONTHLY TYPHOID DEATHS.

From "Veröffentlichungen des Kaiserlichen Gesundheitsamtes."

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|-------------------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|------------|------------|------------|------------|
| 1888 | 4 | 1 | 5 | 3 | 3 | 4 | 3 | 0 | 2 | 2 | 2 | 2 |
| 1889 | 3 | 2 | 2 | 2 | 3 | 2 | 6 | 1 | 1 | 6 | 2 | 1 |
| 1890 | 2 | 1 | 3 | 2 | 2 | 0 | 2 | 4 | 2 | 5 | 4 | 1 |
| 1891 | 2 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 3 | 0 | 2 |
| 1892 | 2 | 1 | 0 | 0 | 1 | 3 | 0 | 1 | 2 | 0 | 1 | 0 |
| 1893 | 3 | 3 | 0 | 1 | 1 | 20 | 15 | 9 | 1 | 3 | 1 | 0 |
| 1894 | 0 | 0 | 1 | 2 | 0 | 1 | 3 | 0 | 2 | 0 | 0 | 1 |
| 1895 | 1 | 2 | 1 | 0 | 0 | 1 | 0 | 2 | 3 | 1 | 0 | 4 |
| 1896 | 2 | 2 | 0 | 1 | 1 | 0 | 1 | 3 | 0 | 2 | 1 | 1 |
| 1897 | 0 | 0 | 0 | 2 | 1 | 7 | 7 | 5 | 1 | 0 | 0 | 0 |
| Average Ratio of 100 | 1.9 7.8 | 1.5 6.1 | 1.5 6.1 | 1.6 6.6 | 1.4 5.7 | 4.1 16.7 | 3.8 15.6 | 2.6 10.7 | 1.5 6.1 | 2.2 9.0 | 1.1 4.5 | 1.2 4.9 |

MEAN MONTHLY TEMPERATURE.

From "Beobachtungen der meteorologischen Stationen im Königreich Bayern."

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|-----------------------|----------|----------|---------|---------|----------|----------|----------|----------|----------|---------|---------|----------|
| 1889 | -4 | -3 | -1 | 7 | 15 | 18 | 17 | 16 | 11 | 8 | 1 | -4 |
| 1890 | 1 | -5 | 3 | 7 | 14 | 14 | 16 | 17 | 12 | 6 | 2 | -7 |
| 1891 | -6 | -3 | 3 | 5 | 13 | 16 | 17 | 15 | 13 | 9 | 1 | -7 |
| 1892 | -2 | 1 | 1 | 7 | 13 | 16 | 16 | 19 | 14 | 7 | 3 | -3 |
| 1893 | -9 | 2 | 4 | 9 | 12 | 16 | 18 | 17 | 13 | 9 | 1 | -3 |
| 1894 | -5 | 1 | 4 | 10 | 11 | 14 | 18 | 16 | 11 | 8 | 3 | -1 |
| 1895 | -5 | -8 | 1 | 8 | 11 | 15 | 18 | 17 | 16 | 7 | 5 | 0 |
| Average Fahrenheit | -4 25 | -2 28 | 2 36 | 8 46 | 13 55 | 16 61 | 17 63 | 17 63 | 13 55 | 8 46 | 2 36 | -3 27 |

VIENNA.

MONTHLY TYPHOID DEATHS.

From "Veröffentlichungen des Kaiserlichen Gesundheitsamtes."

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| 1888 | 7 | 7 | 12 | 8 | 7 | 9 | 4 | 4 | 5 | 9 | 5 | 26 |
| 1889 | 18 | 14 | 9 | 9 | 12 | 5 | 5 | 5 | 5 | 9 | 2 | 8 |
| 1890 | 6 | 7 | 7 | 7 | 6 | 6 | 4 | 6 | 11 | 7 | 3 | 7 |
| 1894 | 7 | 5 | 8 | 5 | 8 | 10 | 3 | 12 | 2 | 5 | 4 | 5 |
| 1895 | 5 | 3 | 2 | 2 | 5 | 6 | 13 | 12 | 6 | 11 | 14 | 7 |
| Average | 8.6 | 7.2 | 7.6 | 6.2 | 7.6 | 7.2 | 5.8 | 7.8 | 5.8 | 8.2 | 5.6 | 10.6 |
| Ratio of 100 | 9.8 | 8.2 | 8.6 | 7.0 | 8.6 | 8.2 | 6.6 | 8.8 | 6.6 | 9.3 | 6.3 | 12.0 |

MEAN MONTHLY TEMPERATURE.

From "Jahrbücher der k. k. Central-Anstalt für Meteorologie und Erdmagnetismus."

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|------------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1888 | -3 | -3 | 4 | 8 | 15 | 18 | 18 | 18 | 15 | 8 | 2 | 0 |
| 1889 | -2 | -1 | 1 | 9 | 18 | 20 | 19 | 18 | 12 | 11 | 3 | -4 |
| 1890 | 1 | -2 | 6 | 9 | 16 | 16 | 19 | 21 | 14 | 9 | 4 | -5 |
| 1891 | -6 | -2 | 4 | 7 | 16 | 17 | 18 | 17 | 16 | 12 | 3 | 1 |
| 1892 | -1 | 1 | 2 | 10 | 14 | 17 | 19 | 21 | 16 | 9 | 2 | -2 |
| 1893 | -8 | 2 | 6 | 10 | 14 | 17 | 19 | 19 | 15 | 11 | 3 | 1 |
| 1894 | -3 | 2 | 8 | 15 | 17 | 18 | 23 | 20 | 16 | 12 | 5 | 1 |
| Average | -3 | 0 | 4 | 10 | 16 | 18 | 19 | 19 | 15 | 10 | 3 | -1 |
| Fahrenheit | 27 | 32 | 39 | 50 | 61 | 64 | 66 | 66 | 59 | 50 | 37 | 30 |

CHICAGO.

MONTHLY TYPHOID DEATHS.

From Reports, Local Department of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|-------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|
| 1889 | 30 | 21 | 15 | 12 | 16 | 18 | 29 | 64 | 77 | 68 | 68 | 35 |
| 1890 | 53 | 136 | 103 | 45 | 82 | 107 | 86 | 115 | 95 | 72 | 67 | 47 |
| 1891 | 67 | 61 | 71 | 136 | 408 | 167 | 200 | 182 | 198 | 171 | 150 | 186 |
| 1892 | 311 | 187 | 76 | 56 | 70 | 55 | 211 | 179 | 138 | 92 | 67 | 47 |
| 1893 | 41 | 30 | 41 | 58 | 56 | 60 | 55 | 76 | 86 | 81 | 43 | 43 |
| 1894 | 46 | 26 | 27 | 30 | 31 | 31 | 37 | 52 | 71 | 68 | 38 | 34 |
| 1895 | 30 | 21 | 26 | 30 | 30 | 18 | 36 | 59 | 76 | 90 | 60 | 42 |
| 1896 | 87 | 89 | 65 | 33 | 31 | 44 | 58 | 64 | 87 | 89 | 60 | 44 |
| 1897 | 38 | 46 | 41 | 19 | 13 | 23 | 27 | 42 | 48 | 61 | 44 | 35 |
| 1898 | 29 | 32 | 41 | 94 | 67 | 35 | 55 | 45 | 65 | 62 | 56 | 55 |
| Average Ratio of 100 | 75 8.8 | 59 7.0 | 51 6.0 | 51 6.0 | 80 9.5 | 56 6.7 | 79 9.4 | 88 10.5 | 94 11.2 | 85 10.1 | 65 7.7 | 57 6.8 |

MEAN MONTHLY TEMPERATURE.

From "Monthly Weather Review," U. S. Weather Bureau.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1888 | 15 | 23 | 30 | 45 | 53 | 67 | 72 | 69 | 60 | 48 | 41 | 31 |
| 1889 | 29 | 20 | 38 | 47 | 57 | 62 | 70 | 71 | 63 | 49 | 39 | 41 |
| 1890 | 31 | 32 | 29 | 46 | 53 | 70 | 72 | 68 | 60 | 51 | 42 | 31 |
| 1891 | 30 | 29 | 31 | 47 | 53 | 66 | 67 | 69 | 69 | 53 | 34 | 35 |
| 1892 | 19 | 30 | 31 | 44 | 52 | 64 | 72 | 71 | 64 | 54 | 35 | 23 |
| 1893 | 12 | 21 | 33 | 44 | 52 | 68 | 74 | 70 | 64 | 53 | 36 | 25 |
| 1894 | 27 | 23 | 41 | 47 | 56 | 71 | 73 | 71 | 66 | 52 | 34 | 32 |
| 1895 | 18 | 17 | 32 | 46 | 59 | 70 | 70 | 72 | 69 | 46 | 36 | 30 |
| 1896 | 27 | 27 | 31 | 53 | 65 | 67 | 72 | 73 | 61 | 50 | 38 | 33 |
| 1897 | 22 | 29 | 35 | 46 | 55 | 65 | 74 | 69 | 69 | 58 | 39 | 25 |
| Average | 23 | 25 | 33 | 46 | 55 | 67 | 72 | 70 | 64 | 51 | 37 | 32 |

PHILADELPHIA.

MONTHLY TYPHOID DEATHS.

From Reports, Local Department of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|-------------------------|------------|-----------|-----------|-----------|------------|-----------|-----------|------------|-----------|-----------|-----------|-----------|
| 1888 | 63 | 46 | 40 | 37 | 84 | 49 | 62 | 169 | 100 | 67 | 36 | 32 |
| 1889 | 62 | 79 | 61 | 41 | 64 | 50 | 68 | 83 | 70 | 63 | 33 | 66 |
| 1890 | 126 | 54 | 52 | 52 | 51 | 36 | 56 | 62 | 57 | 47 | 39 | 34 |
| 1891 | 50 | 44 | 102 | 141 | 76 | 42 | 49 | 42 | 53 | 35 | 23 | 26 |
| 1892 | 51 | 68 | 51 | 37 | 30 | 24 | 20 | 40 | 44 | 37 | 11 | 27 |
| 1893 | 43 | 34 | 38 | 35 | 61 | 37 | 26 | 47 | 47 | 29 | 25 | 35 |
| 1894 | 43 | 18 | 20 | 25 | 36 | 24 | 29 | 50 | 34 | 31 | 29 | 31 |
| 1895 | 36 | 64 | 48 | 40 | 39 | 38 | 33 | 36 | 32 | 43 | 30 | 30 |
| 1896 | 34 | 23 | 21 | 40 | 46 | 27 | 31 | 38 | 34 | 17 | 28 | 63 |
| 1897 | 36 | 18 | 27 | 41 | 50 | 32 | 25 | 49 | 24 | 20 | 31 | 48 |
| Average Ratio of 100 | 54 10.0 | 45 8.2 | 46 8.4 | 49 9.0 | 54 10.0 | 36 6.7 | 40 7.4 | 62 11.5 | 49 9.0 | 39 7.2 | 28 5.2 | 39 7.2 |

MEAN MONTHLY TEMPERATURE.

From "Monthly Weather Review," U. S. Weather Bureau.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1888 | 28 | 34 | 35 | 51 | 61 | 73 | 72 | 74 | 64 | 50 | 46 | 36 |
| 1889 | 39 | 29 | 42 | 53 | 65 | 71 | 75 | 73 | 66 | 53 | 47 | 44 |
| 1890 | 42 | 41 | 39 | 52 | 63 | 74 | 75 | 74 | 67 | 55 | 46 | 32 |
| 1891 | 36 | 40 | 38 | 54 | 61 | 72 | 72 | 74 | 72 | 55 | 44 | 43 |
| 1892 | 31 | 35 | 36 | 51 | 62 | 74 | 77 | 76 | 67 | 56 | 44 | 33 |
| 1893 | 24 | 32 | 39 | 51 | 61 | 72 | 77 | 76 | 66 | 58 | 44 | 36 |
| 1894 | 37 | 32 | 47 | 51 | 64 | 73 | 78 | 73 | 70 | 57 | 42 | 37 |
| 1895 | 31 | 25 | 38 | 52 | 62 | 74 | 73 | 77 | 72 | 53 | 47 | 39 |
| 1896 | 31 | 34 | 36 | 55 | 67 | 70 | 78 | 77 | 68 | 54 | 50 | 35 |
| 1897 | 31 | 36 | 43 | 53 | 63 | 69 | 76 | 74 | 68 | 58 | 46 | 38 |
| Average | 33 | 34 | 39 | 52 | 63 | 72 | 75 | 75 | 68 | 55 | 46 | 37 |

NEWARK.

MONTHLY TYPHOID CASES.

From Report of Local Department of Health for 1899.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|------|------|------|------|-----|-----|------|------|------|------|------|------|
| 1890 | 93 | 23 | 21 | 17 | 16 | 7 | 20 | 10 | 22 | 27 | 34 | 57 |
| 1891 | 88 | 42 | 43 | 18 | 18 | 11 | 15 | 167 | 207 | 137 | 92 | 38 |
| 1892 | 36 | 27 | 19 | 11 | 4 | 4 | 16 | 32 | 30 | 17 | 16 | 17 |
| 1893 | 5 | 3 | 9 | 6 | 8 | 10 | 11 | 26 | 12 | 21 | 7 | 7 |
| 1894 | 2 | 4 | 6 | 9 | 6 | 3 | 3 | 10 | 13 | 21 | 6 | 5 |
| 1895 | 2 | 3 | 2 | 1 | 6 | 4 | 4 | 31 | 38 | 21 | 21 | 15 |
| 1896 | 10 | 5 | 3 | 2 | 3 | 6 | 4 | 14 | 25 | 29 | 7 | 8 |
| 1897 | 5 | 5 | 11 | 7 | 5 | 2 | 8 | 7 | 14 | 11 | 13 | 15 |
| 1898 | 5 | 3 | 2 | 3 | 3 | 7 | 6 | 38 | 59 | 29 | 16 | 8 |
| 1899 | 2 | 2 | 301 | 67 | 27 | 9 | 19 | 28 | 30 | 12 | 10 | 8 |
| Average | 24.8 | 11.7 | 41.7 | 14.1 | 9.6 | 6.3 | 10.6 | 36.3 | 45.0 | 32.5 | 22.2 | 17.8 |
| Ratio of 100 | 9.2 | 4.3 | 15.4 | 5.2 | 3.6 | 2.3 | 3.9 | 13.4 | 16.7 | 12.0 | 8.2 | 6.6 |

MEAN MONTHLY TEMPERATURE.

From "Monthly Weather Review," U. S. Weather Bureau.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1890 | 39 | 38 | 36 | 49 | 60 | 71 | 73 | 72 | 65 | 54 | 43 | 30 |
| 1891 | 33 | 36 | 36 | 51 | 59 | 69 | 70 | 72 | 69 | 53 | 43 | 41 |
| 1892 | 30 | 34 | 34 | 49 | 59 | 72 | 74 | 73 | 64 | 54 | 41 | 30 |
| 1893 | 22 | 28 | 35 | 47 | 59 | 68 | 74 | 73 | 62 | 55 | 41 | 34 |
| 1894 | 33 | 28 | 43 | 49 | 60 | 70 | 75 | 71 | 67 | 54 | 40 | 35 |
| 1895 | 29 | 25 | 36 | 48 | 61 | 71 | 71 | 74 | 70 | 50 | 45 | 37 |
| 1896 | 29 | 31 | 33 | 53 | 66 | 69 | 76 | 75 | 66 | 53 | 49 | 32 |
| 1897 | 30 | 33 | 40 | 50 | 62 | 67 | 75 | 72 | 66 | 55 | 44 | 35 |
| 1898 | 33 | 33 | 45 | 48 | 58 | 71 | 76 | 76 | 70 | 56 | 43 | 32 |
| 1899 | 29 | 25 | 36 | 49 | 61 | 72 | 74 | 72 | 64 | 56 | 43 | 34 |
| Average | 31 | 31 | 37 | 49 | 60 | 70 | 74 | 73 | 66 | 54 | 43 | 34 |

PARIS.

MONTHLY TYPHOID DEATHS.

From "Annuaire statistique de la ville de Paris."

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|-------------------------|-----------|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 1888 | 146 | 78 | 52 | 58 | 54 | 52 | 81 | 51 | 70 | 65 | 69 | 71 |
| 1889 | 69 | 62 | 57 | 43 | 53 | 71 | 102 | 153 | 120 | 92 | 84 | 208 |
| 1890 | 74 | 39 | 45 | 47 | 51 | 57 | 44 | 54 | 76 | 92 | 71 | 73 |
| 1891 | 65 | 59 | 53 | 47 | 36 | 30 | 37 | 43 | 40 | 39 | 54 | 46 |
| 1892 | 50 | 36 | 48 | 37 | 48 | 78 | 90 | 89 | 97 | 105 | 62 | 59 |
| 1893 | 48 | 49 | 50 | 47 | 29 | 29 | 63 | 73 | 72 | 48 | 33 | 29 |
| 1894 | 25 | 53 | 289 | 84 | 34 | 46 | 33 | 37 | 21 | 22 | 29 | 24 |
| 1895 | 11 | 9 | 13 | 21 | 13 | 25 | 22 | 30 | 43 | 34 | 24 | 26 |
| 1896 | 35 | 17 | 21 | 10 | 25 | 9 | 30 | 35 | 26 | 17 | 28 | 9 |
| Average Ratio of 100 | 52 9.0 | 40 6.9 | 63 10.9 | 39 6.7 | 34 5.9 | 40 6.9 | 50 8.6 | 56 9.7 | 56 9.7 | 51 8.8 | 45 7.7 | 54 9.3 |

MEAN MONTHLY TEMPERATURE.

From "Annuaire statistique de la ville de Paris."

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|-----------------------|---------|---------|---------|---------|----------|----------|----------|----------|----------|---------|---------|---------|
| 1888 | 1 | 0 | 4 | 7 | 13 | 16 | 16 | 16 | 15 | 8 | 8 | 3 |
| 1889 | 1 | 2 | 4 | 9 | 15 | 19 | 18 | 17 | 14 | 10 | 6 | 0 |
| 1890 | 6 | 2 | 6 | 9 | 14 | 15 | 16 | 17 | 15 | 9 | 6 | -3 |
| 1891 | -1 | 3 | 6 | 8 | 12 | 16 | 17 | 16 | 15 | 12 | 5 | 5 |
| 1892 | 2 | 4 | 4 | 10 | 15 | 17 | 18 | 19 | 15 | 9 | 8 | 1 |
| 1893 | -1 | 6 | 9 | 14 | 14 | 18 | 19 | 20 | 15 | 11 | 5 | 3 |
| 1894 | 3 | 5 | 8 | 12 | 12 | 16 | 18 | 17 | 14 | 10 | 7 | 4 |
| 1895 | 0 | -4 | 5 | 11 | 14 | 16 | 18 | 18 | 19 | 9 | 9 | 5 |
| 1896 | 2 | 3 | 9 | 9 | 13 | 17 | 19 | 16 | 15 | 9 | 3 | 4 |
| Average Fahrenheit | 1 34 | 2 36 | 5 41 | 9 48 | 13 55 | 16 61 | 17 63 | 17 63 | 15 59 | 9 48 | 6 43 | 2 36 |

NEW ORLEANS.

MONTHLY TYPHOID DEATHS.

From Reports, Local Department of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|-----|-----|-----|-----|-----|------|------|------|-----|-----|-----|------|
| 1886 | 5 | 3 | 0 | 0 | 2 | 3 | 4 | 3 | 3 | 3 | 1 | 3 |
| 1887 | 2 | 4 | 0 | 1 | 3 | 4 | 1 | 4 | 2 | 4 | 2 | 7 |
| 1890 | 7 | 6 | 3 | 2 | 3 | 6 | 7 | 4 | 2 | 3 | 1 | 6 |
| 1891 | 5 | 1 | 1 | 1 | 3 | 6 | 7 | 6 | 10 | 2 | 4 | 13 |
| 1892 | 4 | 1 | 1 | 2 | 2 | 6 | 3 | 10 | 10 | 2 | 5 | 5 |
| 1893 | 2 | 2 | 5 | 1 | 1 | 6 | 4 | 1 | 4 | 4 | 4 | 5 |
| 1896 | 7 | 2 | 7 | 8 | 4 | 12 | 9 | 14 | 8 | 4 | 4 | 11 |
| 1897 | 10 | 4 | 3 | 7 | 6 | 16 | 21 | 18 | 10 | 11 | 19 | 16 |
| Average | 5.2 | 2.9 | 2.5 | 2.7 | 3.0 | 7.4 | 7.0 | 7.5 | 6.1 | 4.1 | 5.0 | 8.2 |
| Ratio of 100 | 8.5 | 4.7 | 4.0 | 4.5 | 4.9 | 11.9 | 11.3 | 12.2 | 9.9 | 6.7 | 8.1 | 13.4 |

MEAN MONTHLY TEMPERATURE.

From "Monthly Weather Review," U. S. Weather Bureau.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1888 | 56 | 59 | 60 | 70 | 73 | 77 | 81 | 78 | 75 | 68 | 59 | 51 |
| 1889 | 53 | 53 | 61 | 70 | 74 | 78 | 83 | 81 | 79 | 70 | 59 | 64 |
| 1890 | 65 | 64 | 62 | 70 | 74 | 81 | 82 | 81 | 78 | 69 | 64 | 56 |
| 1891 | 53 | 63 | 61 | 68 | 74 | 81 | 81 | 81 | 78 | 68 | 60 | 56 |
| 1892 | 49 | 61 | 59 | 69 | 74 | 79 | 80 | 82 | 77 | 71 | 62 | 56 |
| 1893 | 50 | 61 | 61 | 72 | 76 | 80 | 83 | 82 | 80 | 69 | 60 | 58 |
| 1894 | 58 | 55 | 63 | 71 | 75 | 78 | 79 | 80 | 80 | 71 | 60 | 58 |
| 1895 | 52 | 45 | 62 | 68 | 74 | 80 | 82 | 82 | 82 | 69 | 60 | 54 |
| 1896 | 52 | 56 | 61 | 71 | 78 | 80 | 83 | 83 | 79 | 70 | 65 | 55 |
| 1897 | 51 | 58 | 69 | 68 | 74 | 82 | 84 | 82 | 79 | 74 | 64 | 57 |
| Average | 54 | 57 | 62 | 70 | 75 | 80 | 82 | 81 | 79 | 70 | 61 | 56 |

ATLANTA.

MONTHLY TYPHOID DEATHS.

Obtained, in correspondence, by courtesy of Local Board of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|-----|-----|-----|-----|-----|------|------|------|------|------|-----|-----|
| 1893 | 1 | 1 | 3 | 3 | 4 | 5 | 11 | 13 | 7 | 9 | 5 | 1 |
| 1894 | 0 | 0 | 1 | 1 | 3 | 6 | 11 | 12 | 7 | 6 | 2 | 1 |
| 1895 | 0 | 0 | 3 | 0 | 1 | 3 | 4 | 12 | 14 | 20 | 6 | 5 |
| 1896 | 3 | 2 | 4 | 2 | 3 | 7 | 13 | 8 | 10 | 8 | 5 | 3 |
| 1897 | 1 | 0 | 0 | 1 | 0 | 10 | 10 | 11 | 9 | 6 | 4 | 3 |
| 1898 | 4 | 3 | 1 | 4 | 4 | 5 | 5 | 8 | 8 | 7 | 5 | 2 |
| Average | 1.5 | 1.0 | 2.0 | 1.8 | 2.5 | 6.0 | 9.0 | 10.7 | 9.2 | 9.3 | 4.5 | 2.5 |
| Ratio of 100 | 2.5 | 1.7 | 3.3 | 3.0 | 4.2 | 10.0 | 15.0 | 17.8 | 15.3 | 15.5 | 7.5 | 4.2 |

MONTHLY TEMPERATURE.

From "Monthly Weather Review," U. S. Weather Bureau.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1893 | 36 | 46 | 51 | 64 | 67 | 74 | 81 | 77 | 73 | 62 | 51 | 47 |
| 1894 | 47 | 45 | 57 | 62 | 69 | 76 | 76 | 76 | 73 | 62 | 49 | 46 |
| 1895 | 40 | 34 | 51 | 60 | 67 | 77 | 77 | 77 | 76 | 60 | 52 | 44 |
| 1896 | 42 | 45 | 49 | 66 | 75 | 75 | 78 | 80 | 75 | 61 | 56 | 44 |
| 1897 | 39 | 48 | 55 | 60 | 68 | 79 | 78 | 76 | 74 | 66 | 53 | 45 |
| 1898 | 47 | 43 | 57 | 56 | 73 | 79 | 78 | 77 | 74 | 60 | 49 | 44 |
| Average | 42 | 43 | 53 | 61 | 70 | 77 | 78 | 77 | 74 | 62 | 52 | 45 |

CHARLESTON.

MONTHLY TYPHOID DEATHS.

From Reports, Local Department of Health.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|-----|-----|-----|-----|-----|-----|------|------|------|------|-----|-----|
| 1888 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 7 | 4 | 5 | 4 | 4 |
| 1889 | 3 | 2 | 2 | 4 | 1 | 4 | 3 | 5 | 3 | 5 | 3 | 5 |
| 1890 | 4 | 6 | 3 | 2 | 2 | 6 | 6 | 8 | 4 | 9 | 2 | 4 |
| 1891 | 5 | 2 | 1 | 0 | 0 | 1 | 6 | 3 | 3 | 5 | 2 | 0 |
| 1892 | 5 | 1 | 2 | 1 | 4 | 0 | 3 | 3 | 3 | 3 | 1 | 1 |
| 1893 | 1 | 4 | 2 | 0 | 2 | 1 | 4 | 2 | 4 | 3 | 1 | 0 |
| 1894 | 1 | 2 | 2 | 2 | 1 | 4 | 1 | 2 | 4 | 4 | 2 | 0 |
| 1895 | 1 | 0 | 2 | 1 | 2 | 2 | 10 | 3 | 2 | 5 | 3 | 2 |
| 1896 | 3 | 5 | 3 | 3 | 2 | 6 | 4 | 5 | 4 | 3 | 1 | 5 |
| 1897 | 1 | 2 | 2 | 4 | 0 | 3 | 5 | 5 | 7 | 1 | 3 | 7 |
| Average | 2.7 | 2.7 | 2.0 | 1.7 | 1.5 | 2.9 | 4.4 | 4.3 | 3.8 | 4.3 | 2.2 | 2.8 |
| Ratio of 100 | 7.6 | 7.6 | 5.7 | 4.8 | 4.2 | 8.2 | 12.5 | 12.2 | 10.8 | 12.2 | 6.2 | 7.9 |

MEAN MONTHLY TEMPERATURE.

From "Monthly Weather Review," U. S. Weather Bureau.

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1888 | 51 | 54 | 55 | 66 | 72 | 78 | 78 | 80 | 74 | 64 | 56 | 47 |
| 1889 | 52 | 47 | 55 | 63 | 74 | 77 | 81 | 78 | 76 | 65 | 60 | 60 |
| 1890 | 59 | 61 | 56 | 65 | 73 | 82 | 80 | 80 | 76 | 68 | 62 | 51 |
| 1891 | 50 | 58 | 55 | 65 | 70 | 80 | 80 | 81 | 76 | 64 | 56 | 55 |
| 1892 | 48 | 53 | 55 | 64 | 72 | 78 | 80 | 81 | 75 | 66 | 57 | 52 |
| 1893 | 43 | 56 | 56 | 68 | 72 | 78 | 83 | 79 | 78 | 68 | 58 | 54 |
| 1894 | 53 | 53 | 61 | 65 | 72 | 77 | 79 | 80 | 78 | 68 | 57 | 52 |
| 1895 | 49 | 41 | 56 | 64 | 70 | 79 | 81 | 82 | 78 | 66 | 58 | 51 |
| 1896 | 48 | 52 | 55 | 66 | 77 | 79 | 82 | 81 | 77 | 67 | 63 | 49 |
| 1897 | 47 | 55 | 61 | 66 | 72 | 80 | 82 | 81 | 75 | 70 | 62 | 54 |
| Average | 50 | 53 | 57 | 65 | 72 | 79 | 81 | 80 | 76 | 67 | 59 | 53 |

EMPIRE OF INDIA.

MONTHLY TYPHOID ADMISSIONS, BRITISH TROOPS IN INDIA.

From Report on Sanitary Measures in India in 1896-97. Vol. XXX.

| Period. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|-------------------------|-----------|-----------|------------|-------------|-------------|-------------|-------------|-------------|-------------|-----------|-----------|------------|
| 1886-95 1896 | 518 65 | 418 75 | 689 202 | 1427 214 | 1795 160 | 1365 152 | 1441 175 | 1718 214 | 1400 179 | 923 90 | 745 92 | 879 177 |
| Total | 583 | 493 | 891 | 1641 | 1955 | 1517 | 1616 | 1932 | 1579 | 1013 | 837 | 1056 |
| Average Ratio of 100 | 53 3.9 | 45 3.3 | 81 5.9 | 149 10.9 | 178 13.0 | 138 10.1 | 147 10.7 | 175 12.8 | 144 10.5 | 92 6.7 | 76 5.5 | 96 7.0 |

MONTHLY RANGE OF TEMPERATURE.

From "Handbuch der Klimatologie," J. Hann. Zweite Auflage. Stuttgart, 1897.

Difference between the monthly mean and the yearly mean. Central India, Deccan, 20.8° N., 78.0° E., 390 M.

| J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|----|----|----|----|----|----|----|----|----|----|----|----|
| -6 | -3 | 2 | 6 | 8 | 3 | 0 | 0 | 0 | 0 | -4 | -7 |

Punjab, 31.1° N., 72.3° E., 200 M.

| J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|-----|-----|----|----|----|----|----|----|----|----|----|-----|
| -12 | -10 | -3 | 3 | 7 | 10 | 9 | 7 | 6 | 0 | -7 | -11 |

SANTIAGO DE CHILE.

Typhoid cases received at Hospital S. Francisco de Borja and Hospital S. Juan de Dios, 1886-1895.

Figures from essay, "La Fiebre Tifoidea en Santiago," by Pedro V. Garcia, P., "Revista Chilena de Higiene." Tomo III, Núm. 11.

| | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|------|
| Total | 121 | 121 | 102 | 87 | 65 | 49 | 52 | 47 | 49 | 60 | 73 | 107 |
| Ratio of 100 | 13.0 | 13.0 | 11.0 | 9.4 | 7.0 | 5.3 | 5.6 | 5.1 | 5.3 | 6.5 | 7.8 | 11.5 |

MEAN MONTHLY TEMPERATURE.

From "Observaciones meteorológicas hechas en el Observatorio Astronómico de Santiago."

| Year. | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|-----------------------|----------|----------|----------|----------|----------|---------|---------|---------|----------|----------|----------|----------|
| 1882 | 20.7 | 18.9 | 16.4 | 12.6 | 10.3 | 8.0 | 7.4 | 9.5 | 12.4 | 15.2 | 16.6 | 18.4 |
| 1883 | 19.1 | 18.9 | 15.3 | 12.8 | 9.9 | 7.5 | 6.8 | 8.9 | 10.8 | 13.3 | 16.2 | 18.9 |
| 1884 | 21.7 | 18.2 | 15.3 | 13.3 | 9.0 | 7.0 | 6.4 | 10.3 | 10.9 | 13.2 | 16.4 | 19.0 |
| 1885 | 18.7 | 18.3 | 16.4 | 10.3 | 8.8 | 7.5 | 6.4 | 9.4 | 12.6 | 13.5 | 18.0 | 17.4 |
| 1886 | 19.9 | 18.1 | 16.5 | 13.4 | 10.2 | 6.2 | 8.1 | 8.7 | 11.5 | 14.4 | 16.5 | 19.4 |
| 1887 | 19.8 | 18.4 | 16.4 | 13.1 | 9.7 | 8.5 | 8.6 | 10.5 | 11.7 | 13.4 | 16.0 | 18.1 |
| Average Fahrenheit | 20 68 | 18 64 | 16 61 | 13 55 | 10 50 | 7 45 | 7 45 | 9 48 | 12 54 | 14 57 | 16 61 | 18 64 |

BUENOS AYRES.

MONTHLY TYPHOID DEATHS, 1876-1897.

| | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|--------------|------|-----|------|------|------|-----|-----|-----|-----|-----|-----|-----|
| Total | 573 | 534 | 632 | 728 | 642 | 487 | 317 | 284 | 233 | 262 | 317 | 432 |
| Ratio of 100 | 10.4 | 9.8 | 11.6 | 13.4 | 11.8 | 9.0 | 5.8 | 5.2 | 4.3 | 4.8 | 5.8 | 7.9 |

MEAN MONTHLY TEMPERATURE, 1876-1897.

Figures from essay, "La Fiebre Tifoidea en Buenos Aires," by Dr. Diego T. R. Davison, "Anales del Departamento Nacional de Higiene." Año VIII. Núm. 13.

| | J. | F. | M. | A. | M. | J. | J. | A. | S. | O. | N. | D. |
|------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Centigrade | 23.5 | 22.8 | 21.2 | 16.7 | 13.2 | 10.3 | 10.4 | 11.5 | 13.3 | 16.1 | 19.8 | 22.4 |
| Fahrenheit | 73 | 73 | 70 | 63 | 55 | 50 | 50 | 53 | 55 | 61 | 68 | 72 |

III. INTERPRETATION OF THE STATISTICAL RESULTS.

An examination of the curves plotted as above described shows that a very striking parallelism exists between the monthly variations in temperature and typhoid prevalence. Of the thirty communities considered, eighteen show this parallelism to be almost perfect; these are the Empire of Japan, the States of New York and Massachusetts, the District of Columbia, and the cities of Atlanta, Baltimore, Berlin, Boston, Buenos Ayres, Denver, Leipsic, London, Mobile, Montreal, New York, St. Paul, San Francisco, and Santiago. Three other typhoid curves — those for India, for Charleston, and for New Orleans — rise with the temperature in spring, and fall with it in autumn, but show a temporary decrease in the disease during the time of greatest heat. In all these twenty-one cases the connection between the two factors seems too close not to indicate a vital relation. In the northern cities — Montreal, Boston, Denver, and St. Paul — the curve of typhoid is acute; in cities with a more and more equable temperature the curve of the disease is progressively flattened, the limit being reached in the case of San Francisco. In the northerly localities the maximum occurs in September and October; in the southern cities, with a milder winter, it comes in August (Atlanta) or July (Charleston and Mobile). In the two cities of the southern hemisphere the curves of both typhoid fever and temperature are exactly reversed. In the case of the tropical and sub-tropical regions — India, Charleston, and New Orleans — it appears that the rise with the temperature, after beginning in the usual fashion, is checked by some other factor, perhaps strong sunlight or extreme dryness. (See Plates I.–VIII.)

It remains now to consider the nine cities which show more or less irregular curves, and to see if their abnormalities are capable of explanation. These nine cities are Chicago, Cincinnati, Dresden, Munich, Newark, Oakland, Paris, Philadelphia, and Vienna. The first thing to notice in this connection, and the one all previous students of seasonal variation have neglected is the necessity of discriminating between sharp epidemic outbreaks of the disease and the slow succession of isolated cases which characterize that condition known to the older sanitarians as “endemic.” The term endemic has been so misused and has become so associated with the idea of a mysterious miasm inherent in a geographical region, that it cannot be safely used in a more scientific sense. At the same time a distinction, vital to the epidemiologist, must be drawn between the infection which reaches a number of persons at once through a single medium as water or milk, and the slower, more complex process by which a disease passes from person to person through a population, the path of the

contagious material being different in each individual instance. For this sort of infection which spreads gradually in a community instead of striking a large number of persons at a single blow, the term "prosodemic," meaning "through" or "among" the people, has been suggested.

In the examination of data bearing on the question of the seasonal prevalence of typhoid fever it is obviously the prosodemic disease which should be mainly considered. Cases of this sort furnish a large number of independent facts which may be averaged together fairly; while an epidemic must always be a perturbing element. Thus, for example, a public water supply furnishes exceptional facilities for the distribution of infection from its watershed to a large number of individuals. Twelve hundred cases of typhoid fever at Plymouth, Pa., derived from a single house on the banks of a reservoir have, for a study of normal seasonal variations, far less significance than fifty cases, in which the paths of infection are separate and independent.

Curves of seasonal variation which are based on a small number of cases will always be liable to show irregularities due to single epidemics; and if our tables of typhoid deaths be inspected, it will at once be seen that four of the nine exceptions to a regular seasonal distribution are due to this cause. Thus the form of the Oakland curve is distorted by the epidemic of twenty-two deaths in July, 1893, which we are informed by the local authorities was due to an infection of the milk supply. The largest number of deaths in any other month in the ten years was seven, so that this irregularity could not be compensated. Similarly, the Munich curve owes its peculiarity to the epidemic of thirty-five deaths in June and July of 1893, the largest number in any other month being nine. The curve for Vienna is controlled, in a similar way, by an epidemic in December, 1888, and January and February, 1889. In all these cases the curve would follow the temperature more or less normally if these perturbations were eliminated. Again for Dresden the total number of deaths is so small that eight cases in April, 1894, cause a notable distortion. That the typhoid in this city did follow the temperature when there was enough of it to give average results is shown by Fiedler's figures for 1850-60, quoted above.

We may thus consider that the irregularities of the Oakland, Munich, Vienna, and Dresden curves are explained by the fact that the number of cases considered is too small to eliminate the haphazard effect of epidemics. There remain to be explained the exceptions offered by Chicago, Cincinnati, Newark, Paris, and Philadelphia, in all of which cities the amount of material is amply sufficient to prevent mere chance irregularities. If the curves for these five cities be compared, it will at once be noted that they exhibit a remarkable resemblance. Besides the summer rise, each curve

exhibits two secondary maxima, one in December or January, the other between March and May. If our general theory be correct, there must in these localities be some special condition tending to produce typhoid epidemics in the early winter and the early spring, which modifies the normal influence of the season. Fortunately, we know exactly what this influence is. These five cities — and of the thirty communities we have considered, these five only — draw their water supply from surface sources liable to gross pollution. The epidemics of March, 1899, at Newark; of May, 1891, at Chicago; of January, 1888, and December, 1889, at Paris, as well as the lesser winter and spring outbreaks in other years, were unquestionably due to the public water supplies of those cities. We have here then a special condition influencing the occurrence of epidemics in cities having surface water supplies and therefore deranging the normal course of prosodemic typhoid. The heavy autumn rains and the spring floods consequent on the melting of the winter's snow, carry into surface water supplies a larger amount of pollution than reaches them at any other time, — as is well shown by a comparison of the bacterial content of surface water at various seasons. We may venture to generalize by saying that winter and spring epidemics are characteristic of those cities whose water-supply is most subject to pollution; they are absent from communities which use filtered water or water obtained from adequately protected watersheds.

Finally, then, it appears that of the thirty communities we have studied, all but four, in which the number of cases is too small to furnish average results, give typhoid curves corresponding to one of three types, — the normal temperature distribution, the subtropical modification, and the modification due to winter and spring water-epidemics. These latter types of distribution are explicable as the resultant of a combination of the temperature factor with another. We may therefore conclude that wherever a sufficient number of cases has been considered a direct relation between typhoid fever and temperature appears to be general and invariable.

IV. CONCLUSION OF THE AUTHORS THAT THE SEASONAL PREVALENCE OF TYPHOID FEVER DEPENDS MAINLY UPON SEASONAL TEMPERATURE.

The increase of typhoid fever with a gradual rise in the mean air temperature of a given locality appears to be a phenomenon so widespread and significant as to indicate beyond reasonable doubt some relation between the two factors. Whether this relation be direct or indirect must be determined by considerations as to the ætiology of the disease and as to the relation of temperature to the various vehicles mainly concerned in its transmission.

The methods by which prosodemic typhoid may spread are almost innumerable. The last link in the chain is, in most cases, some article of food or drink, and the food becomes infected, in many instances, from the fingers of a typhoid patient or of his unprofessional attendants. The transmission of typhoid fever on a large scale by water and milk has led sanitarians to minimize unduly this direct personal element in its ætiology. In a well-organized, thoroughly sanitary city dwelling the distinction between contagion and infection is an important one; but in dirty surroundings typhoid becomes, for all practical purposes, a contagious disease. This fact, in itself, throws some little light on its seasonal prevalence. A large number of persons who live ordinarily in cities, surrounded by many sanitary safeguards, in vacation time are exposed in camps and summer resorts to abundant opportunities for filth infection. The autumn fever, in small part at least, occurs among those who are attacked on such summer vacations or immediately after their return home.

Again, several special sources of food contamination have a more potent influence at this season of the year. Those observers are perhaps correct who consider that ground waters are most dangerous when the wells are at their lowest and liable to receive impurities from a wide area. Professor Gualdi would explain the facts by attaching great significance to raw vegetables as vehicles for the transmission of typhoid fever; and he has traced out a more or less close connection between the consumption of these articles and the amount of typhoid in Rome. Most original of all is the suggestion of Bonne, who seeks to explain the autumnal maximum at Hamburg by the increased amount of bathing in the Elbe beginning with the July heat.

Of the three great intermediaries of typhoid transmission, fingers, food, and flies, the last is even more significant than the others in relation to seasonal variation. Since the emphasis laid on this vehicle of infection by the surgeons who studied the conditions of the late Spanish War, our conception of its importance has grown more and more considerable. There can be little doubt that many of the so-called "sporadic" cases of typhoid fever which are so difficult for the sanitarian to explain are conditioned by the passage of a fly from an infected vault to an unprotected table or an open larder. The relation of this factor to the season is of course close and complete; and a certain amount of the autumnal excess of fever is undoubtedly traceable to the presence of large numbers of flies and to the opportunities for their pernicious activity.

None of the factors noted, however, nor the whole of them taken together, seem to us to account satisfactorily for the observed phenomena. Neither the agency of insects, nor the exposure of urban subjects to rural unsanitary conditions, though both are undoubtedly important, can be held to account for a phenomenon so con-

stant, so striking, and so universal. The parallelism between the curves of typhoid and of temperature is too close not to suggest in the strongest manner some direct relation such as was postulated by Murchison, Liebermeister, and Davidson. No one doubts a direct correlation between the growth in a wheat-field and the changes of temperature during the changing seasons. The fundamental properties of protoplasm are so constant that there seems no reason to doubt a similar favorable effect of the warmth of summer, not on the crop of typhoid plants growing in human bodies, but on the survival seed which passes from one body to another through the environment. This is theoretical; but the experiments reported in the first section of this paper furnish practical evidence to confirm the *à priori* hypothesis that it must be more difficult for an organism habituated to a temperature of 98° F. to persist in Nature when the thermometer is at 30° than when it is in the neighborhood of 80°.

We do not wish to assert that the typhoid bacillus multiplies in the environment during the summer months of a temperate climate. It is the absence of the destructive influence of cold, rather than any stimulating influence of heat, which permits the rise culminating in the autumnal maximum.

In fine, the probable mechanism of the seasonal changes according to our conception is as follows:—

The bacteriology and the ætiology of typhoid fever both indicate that its causal agents cannot be abundant in the environment during the colder season of the year. The germs of the disease are carried over the winter in the bodies of a few patients and perhaps in vaults or other deposits of organic matter where they are protected from the severity of the season. The number of persons who receive infection from the discharge of these winter cases will depend, other things being equal, upon the length of time for which the bacteria cast in these discharges into the environment, remain alive and virulent. The length of the period during which the microbes live will depend largely upon the general temperature; as the season grows milder, more and more of each crop of germs sent at random into the outer world will survive long enough to gain entry to a human being and bear fruit. The process will be cumulative. Each case will cause more secondary cases; and each of the latter will have a still more extensive opportunity for widespread damage. In our opinion the most reasonable explanation of the seasonal variations of typhoid fever is a direct effect of temperature upon the persistence in Nature of germs which proceed from previous victims of the disease.

EXPLANATION OF THE PLATES.

Plates I.–VIII. are based upon the statistics given on pp. 540–566, as is stated on p. 539. Abscissæ indicate months; ordinates indicate temperatures (shown by broken lines), and also percentages of yearly typhoid-fever mortality (solid lines) except in the curves for Newark, N. J. (Plate VI.), the Empire of India (Plate VII.), and Santiago de Chile (Plate V.), in which deaths, not cases, are indicated.

It is important to remember that the curve of typhoid deaths in each case has been moved back exactly two months from its true position, and that for typhoid cases one month, as is explained on p. 539.

PLATE I.

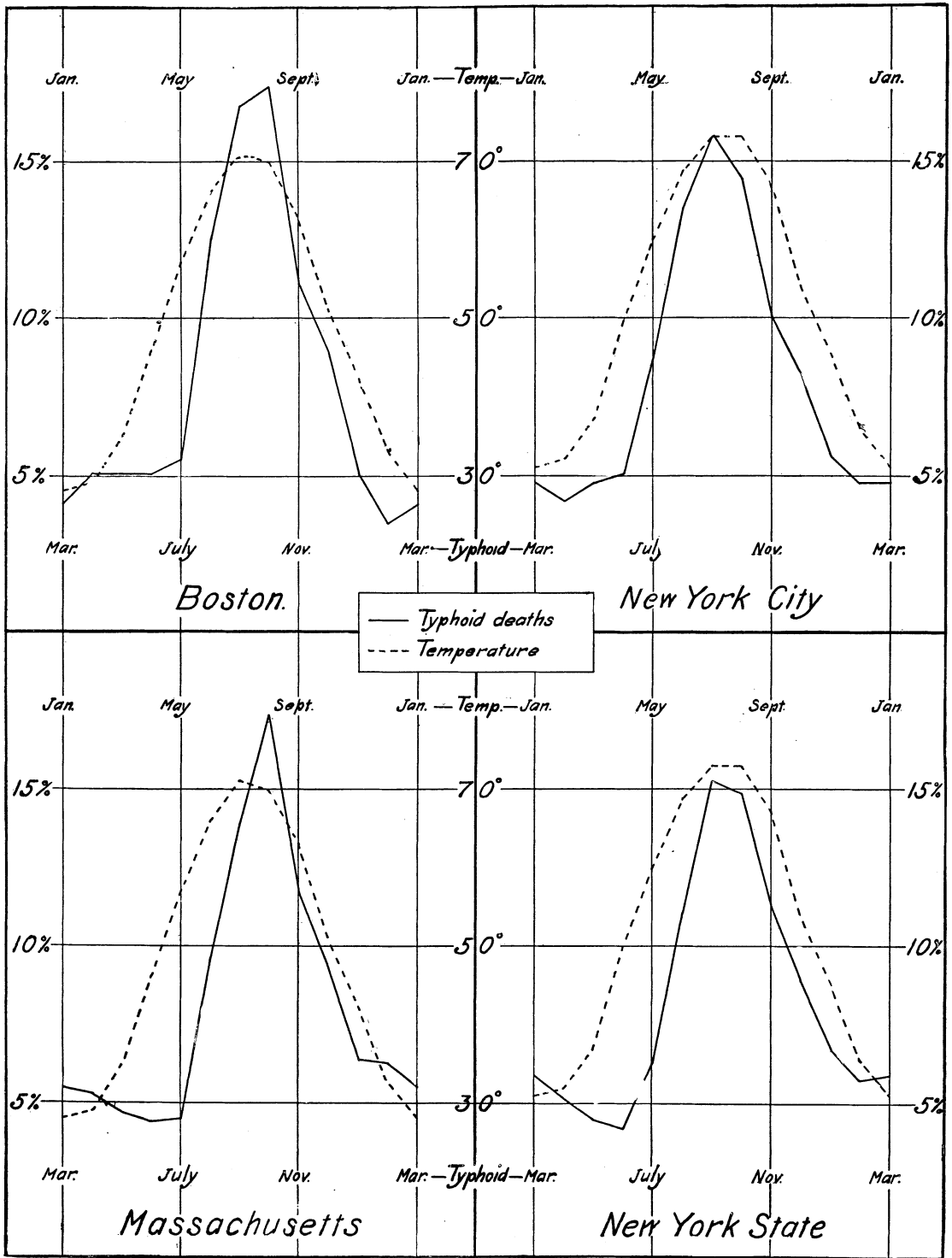


PLATE II.

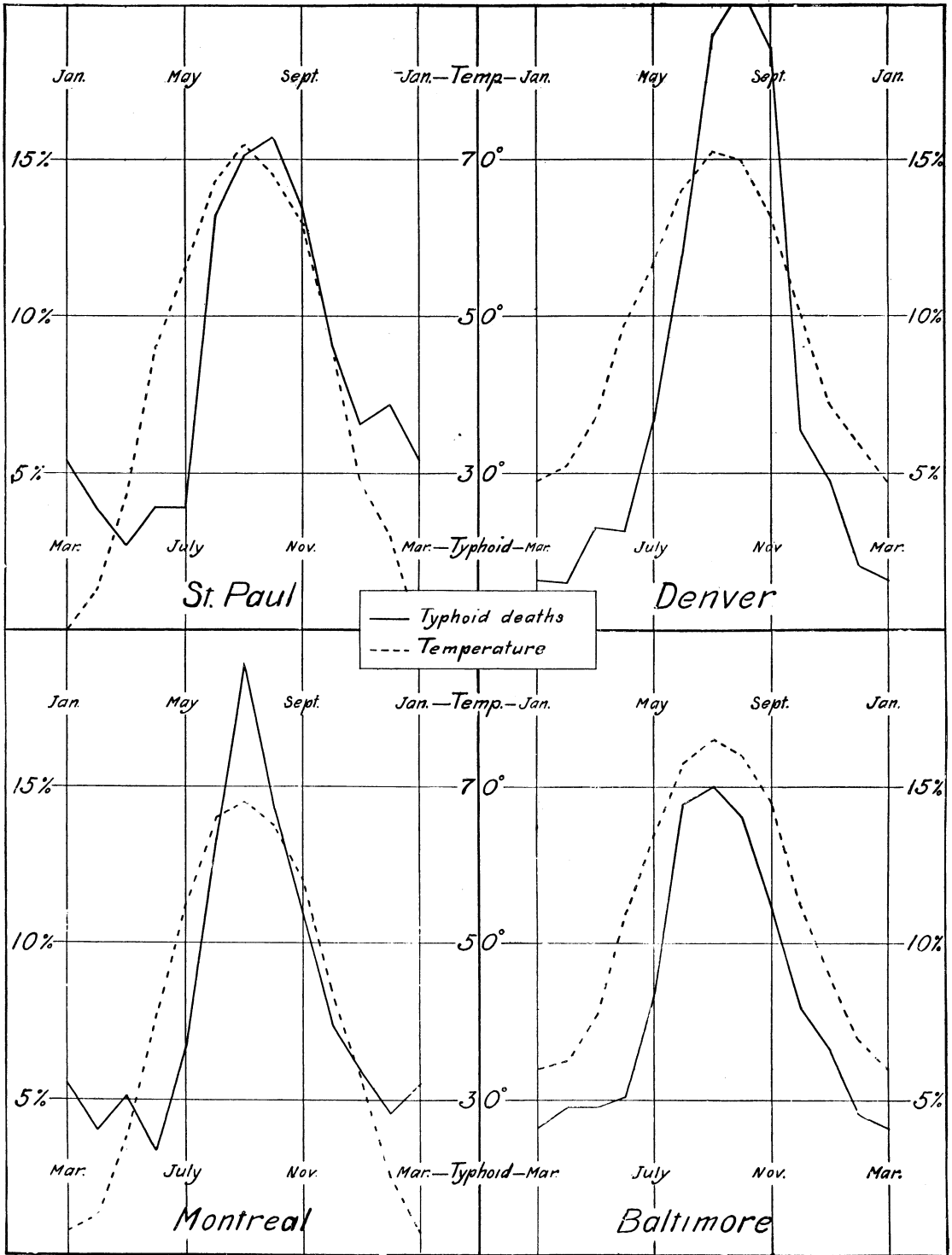


PLATE III.

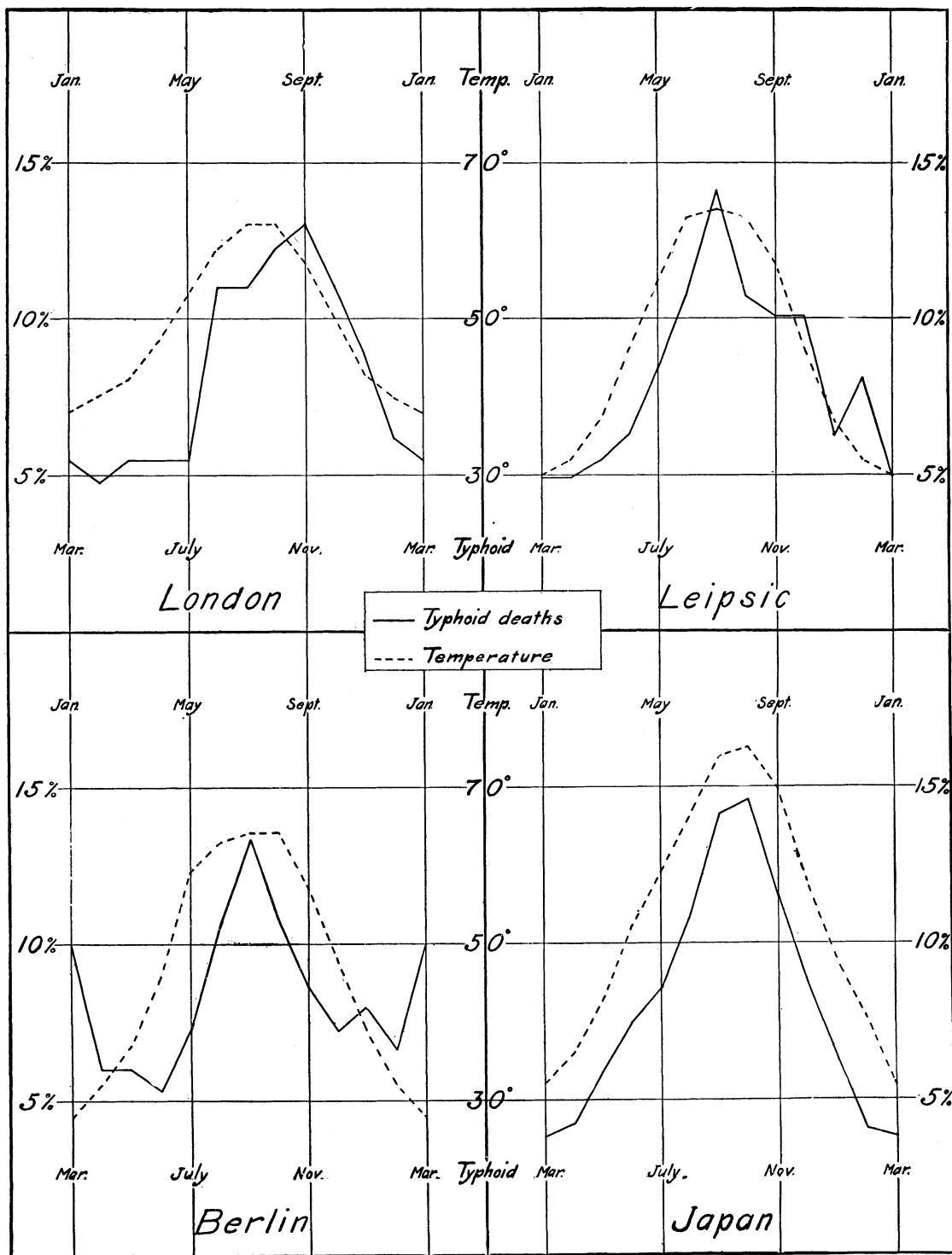


PLATE IV.

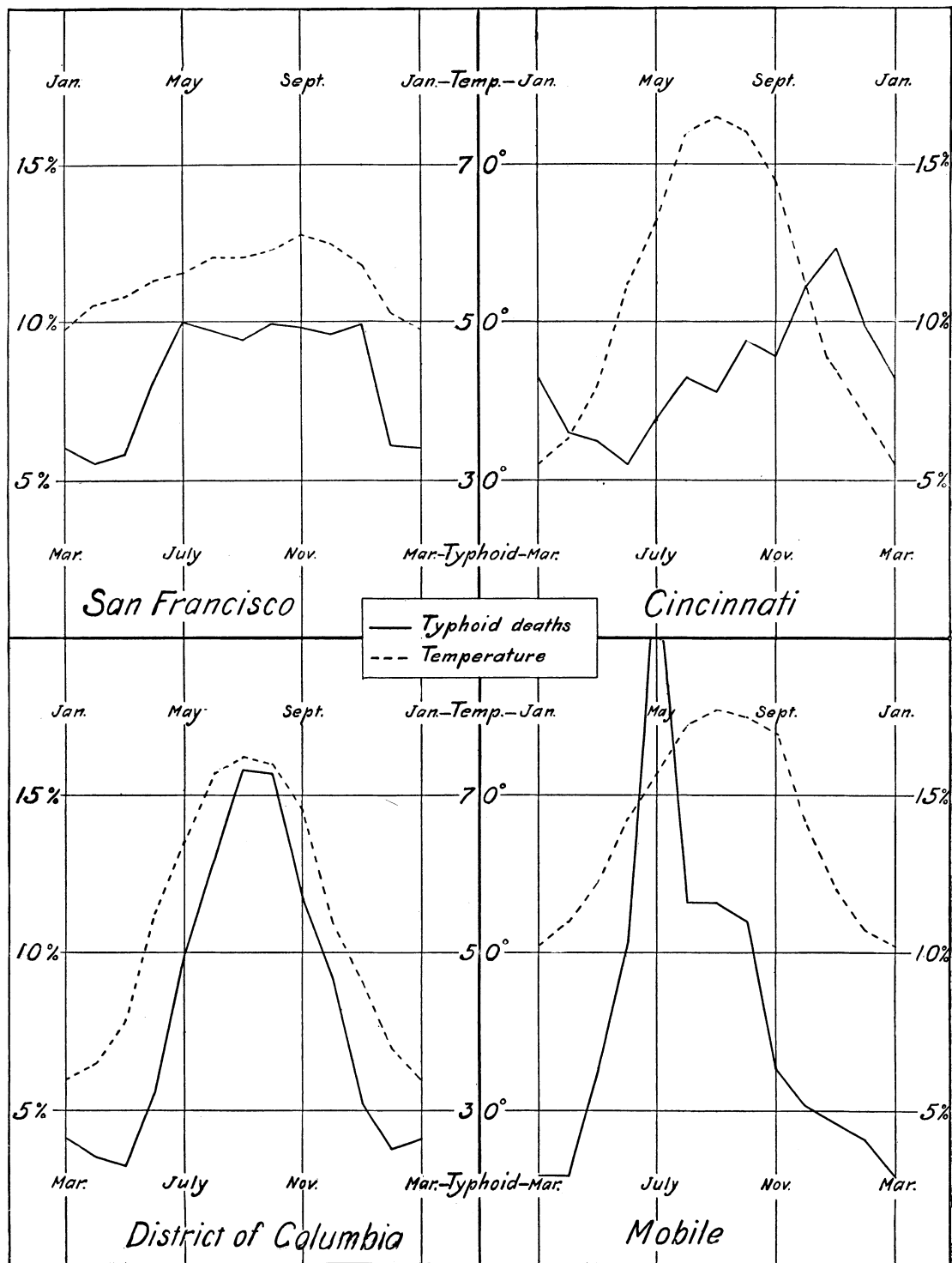


PLATE V.

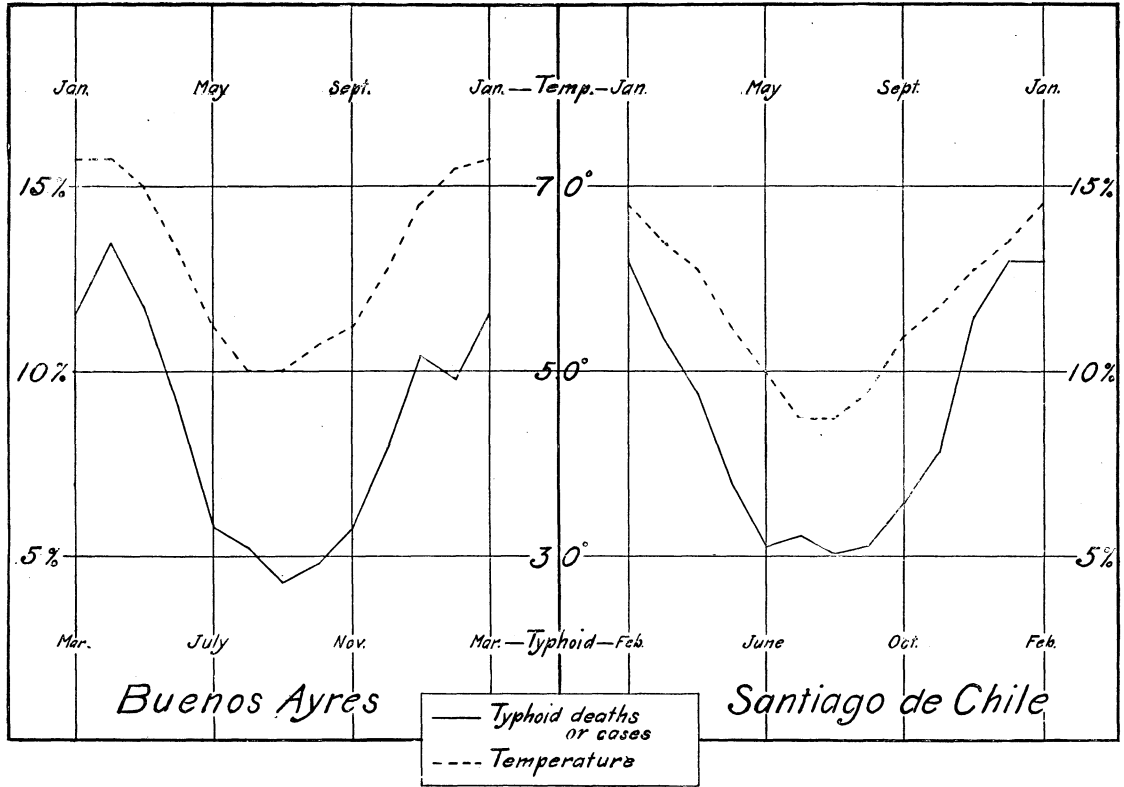


PLATE VI.

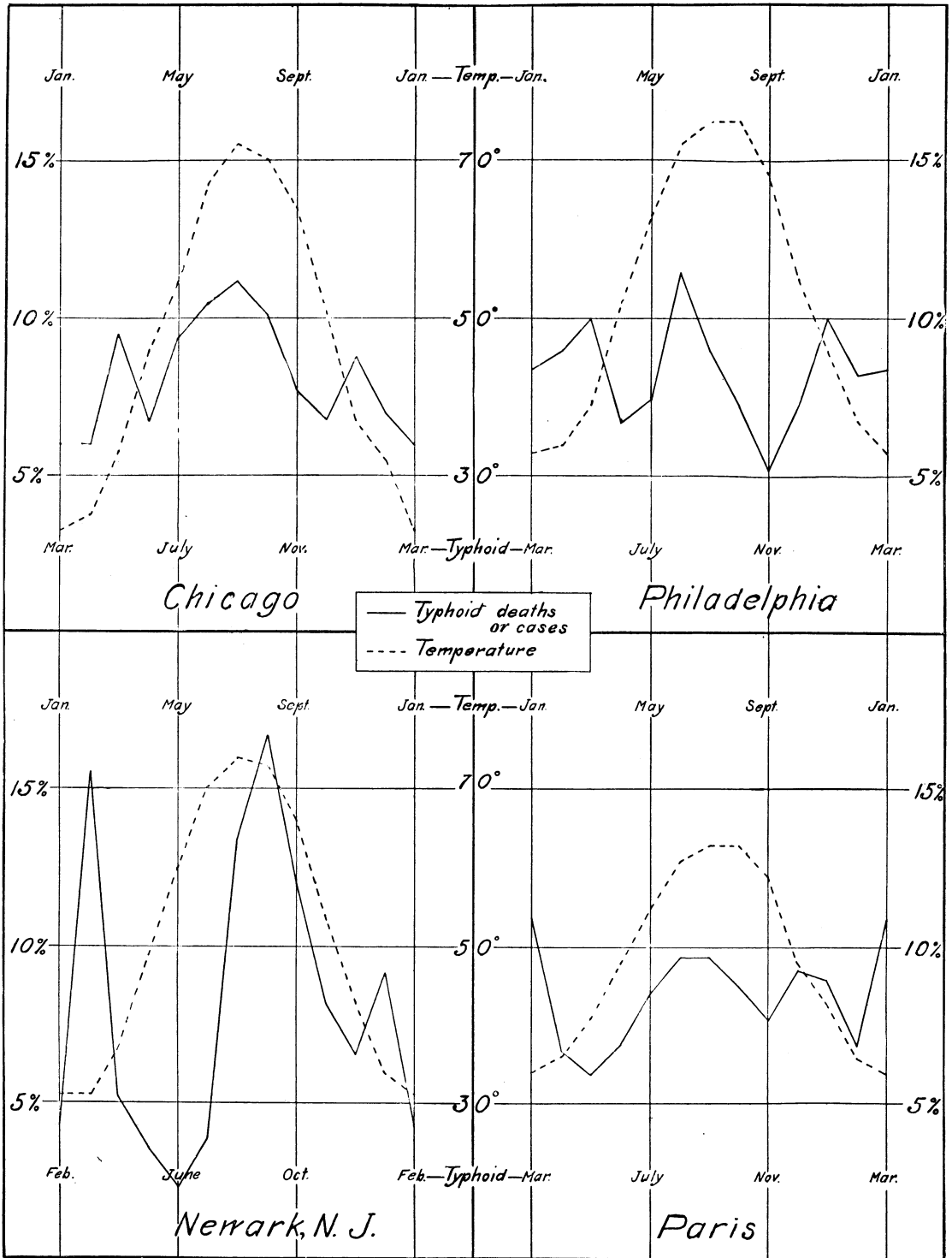


PLATE VII.

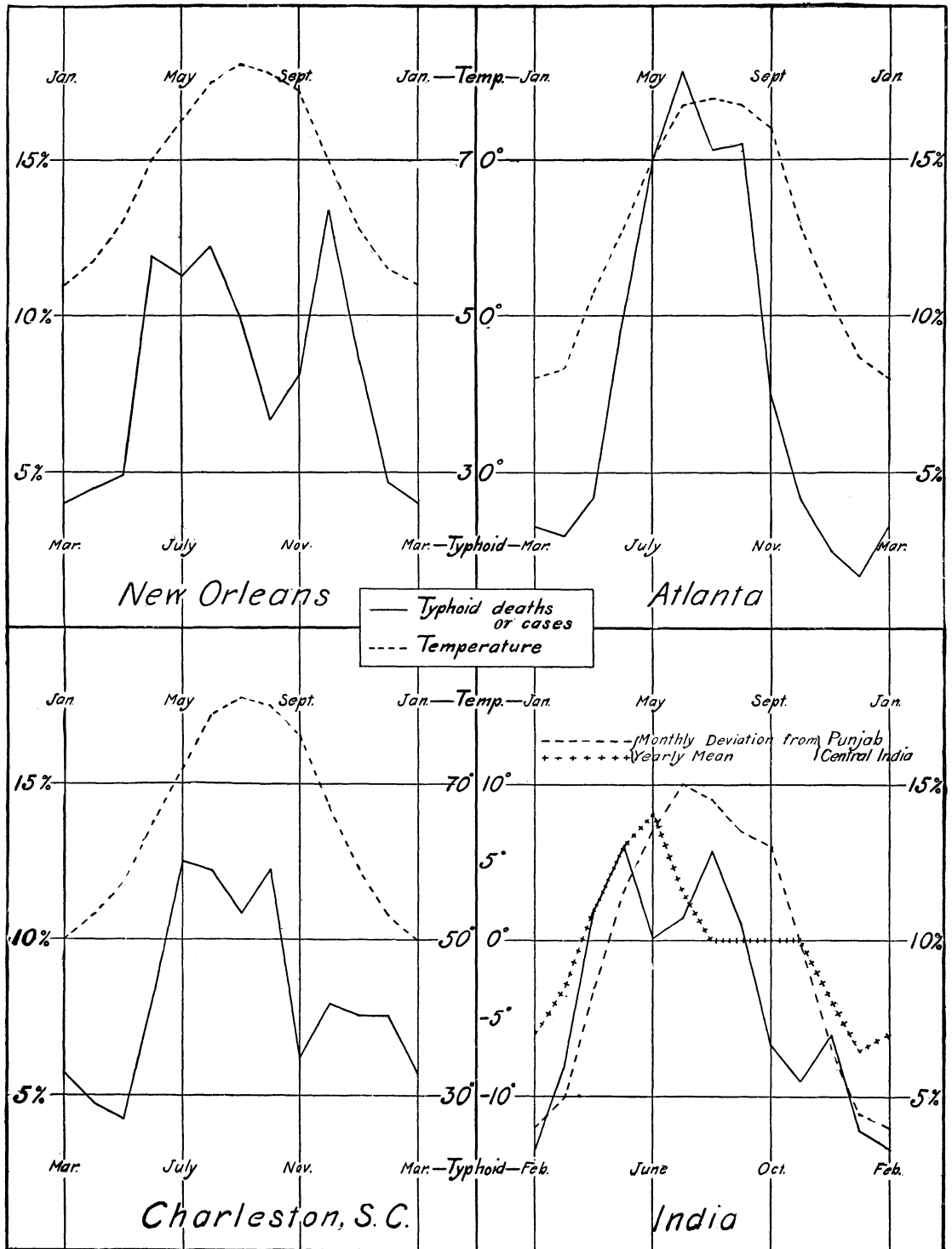


PLATE VIII.

